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FastTrack

YOUR HANDY GUIDE TO EVERYDAY TECHNOLOGY

MAY

To

TOP 100 INVENTIONS OF ALL TIME

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05

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MANKIND'S TOP 100 INVENTIONS

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Introduction

Since the time primordial man first picked up a rock and thwacked a scurrying rodent on its head to fix his dinner, mankind has always been inventing things. Improvising, innovating, crafting tools out of almost nothing to overcome the many difficulties of day-to-day life. Whether it was the rudimentary spear crafted by sharpening the end of a stick or much later a simple chair, inventions have shaped our very evolution.

Before you get worried we'll assure you we've not gone that far back in time in this Fast Track. Being Digit, to come up with mankind's top 100 inventions we've (more or less) stuck to technology or inventions that enabled great leaps in technology. The inventions we've covered span core-science aeronautics, biology, physics, medicine, automobiles, electronics and of course technology. We've avoided things like "fire" or "the wheel" because quite frankly no one really knows how the former was discovered (not invented) and who invented the latter. How did we come up with this list? Well the five-member team of self-proclaimed experts (read: Digit old hats) and their apprentices (read: starry-eyed interns) convened and fought tooth and nail over which inventions have had the biggest impact on all the spheres of our day-to-day life. Extensive lists were drawn up and voted upon. Finally after discarding perhaps many items, we finally settled on a list of 100 that we more or less agreed upon. Of course, you'll come across unlikely contenders such as "The Electric

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Guitar” or “Lego” but hey they’re important to some of us. At the same time, there will of course be so many that we missed out on or decided to drop and we’re more than happy to read your angry mails.

Since settling on a list was so difficult thanks to the murderous battles fought internally we decided to drop the idea of ranking them or having a countdown. Who are we to decide if penicillin was a better invention than the internal combustion engine?

Arranged alphabetically, you can either read this booklet start-to-finish or randomly open to a page and enjoy the bite-sized information that awaits you. Happy reading. 

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3D Printers

The 3D Printer is one of the greatest inventions of the 21st century allowing you to turn your ideas into real objects.

The latest Bond movie, Skyfall used a 3D printer from a German company called Voxeljet to produce three 1:3 scaled models of 007's Aston Martin just to blow up during the movie!

What sounds like a really cool toy to have is actually used for some very serious operations. Let's first understand how it works.



3D printing is achieved using an additive process in which successive layers of materials are laid out in different shapes. Cutting and drilling (also known as subtractive processes) are not involved at all making the process easy, efficient and highly suitable for prototyping.

The biggest consumer of the 3D Printer is the medical industry. So far it has produced prosthetics and bones and the ability to generate human organs from these machines is currently being tried out. If this is managed, it could revolutionize medicine and completely obliterate the need for organ donation. Using a 3D printer in conjunction with CAT scans, surgeons can print out tumours so that they know exactly what they're dealing with.

We're sure you're familiar with Pirate Bay, the file sharing company. It has launched a new content category called 'Physibles' i.e. data objects that can be made into physical products. 3D blueprints are uploaded and shared with those who want to print out the actual objects.

Adhesive

Also known as paste or glue, this typically semi-liquid invention bonds items together and is the base for almost millions of products that exist today from labels stuck to bottles to car protection coatings – and the list just keeps growing. Made from natural materials, the oldest known adhesive dates back to approximately 200,000 BC when stone flakes were glued to wood using tar secreted from the bark of the Birch tree to make spears.

Aside from the obvious plant gum being used to create adhesive, history tells us of several alternative materials that can also act as glue. For example, egg whites were used in medieval Europe to decorate parchments



with gold leaf and there are patents for glue made out of horse hooves, fish scales and even mammalian milk.

The miracle of glue is its quick state changing property. For the uninitiated, when glue is applied to an item, it easily gets into the microscopic pores of the object and changes its form into solid thereby attaching two different items. Science aside, possibly the two best inventions that have come about as a result of adhesive are Super Glue and Post-it notes. 3M, the manufacturer of Post-its has a staff of 67,000 employees globally – all of whom wouldn't have a job if adhesive didn't exist.

Air Conditioning

What is literally the coolest invention, the air conditioner, as we all know, is a system designed to change the air temperature and humidity within an area. Here's a surprising fact: this amazing technology developed by Willis Carrier in 1902 was not a comfort-focussed invention, but actually for a publishing company, Sackett-Wilhelms. The AC kept temperature and



humidity low, which kept the paper from expanding and contracting. Movie theatres were early adopters of air-conditioning and the term 'summer blockbuster' actually came about because people would flock to air-conditioned movie theatres to escape the summer heat. Even the concept of summer school vacations came into existence because of the AC. Hot stuffy schools were intolerable so kids were given a break during this time. Even with the introduction of AC, this holiday tradition has continued.

Not only has air conditioning enabled exponential advances in medicine such as defeating malaria and decreasing infant mortality it has also completely changed the way we design and construct buildings and homes.

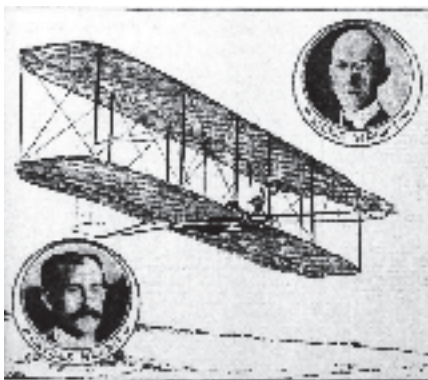
While we may not think much about the AC quietly humming away in the background, the development of effective temperature control using the AC has revolutionized almost every aspect of industry. Addictive as the cool temperature may be, without ACs the manufacture of computers and data storage centres; the production, delivery and storage of food; pharmaceutical manufacturing as well as chemical manufacturing would all be virtually impossible.

Airplane

The Wright brothers are given credit for the invention of the Airplane in 1903. The first flight lasted a little over 12 seconds at Kill Devil Hill, Northern Carolina. Since then, much progress has been made in the world of aviation. The sky wasn't the limit here. War and sci-fi stories inspired great minds like Konstantin Tsiolkovsky and Werner von Braun to achieve flight beyond the atmosphere, making space travel a possibility.

The invention of the airplane sped up services in every single field starting with the postal service in 1920. World War II in 1939 kick-started

developments in the aviation sector. Countries competed with each other to one-up the others' sophisticated developments, with the British developing the airplane-detecting radar followed by the Germans developing radio wave navigation techniques. Fighter jets, advanced landing systems and high altitude aircrafts followed.



In 1947, US Air Force Pilot Captain Charles Yeager broke the sound barrier in the first supersonic flight becoming the fastest man alive.

Commercial flights started not long after and now, well, an airplane makes a landing somewhere around the world every three seconds!

Air travel is considered to be the safest form of travel in the world. A funny but true fact reveals that donkeys kill more people annually than plane crashes. In spite of these phenomenal odds, 80% of the population of the world has Aerophobia, viz fear of flying. In some (5%) this fear is so intense that they abandon flights and opt for other modes of transport.

We've come a long way since 1903. In fact the wingspan of a Boeing 747 is longer than the Wright brothers' first flight! The world today would be crippled without the discovery of flight. Businesses would crash, economies would slow down, worse still, holidays would be cancelled!

Alloys

An Alloy is a combination of two or more elements to form a metallic solid solution. It's an impure substance formed by two or more pure or semi-pure substances. It is the impurities that add the desired characteristics to the alloy.

The discovery of alloys dates back to prehistoric times when man discovered that iron could be strengthened with the addition of carbon to create wrought iron and copper and tin could be combined to make bronze. This was the beginning of the Bronze Age with stronger weapons, sturdier utensils and shinier jewellery.

Alloys are essential to all fields – construction, transportation, medicine,

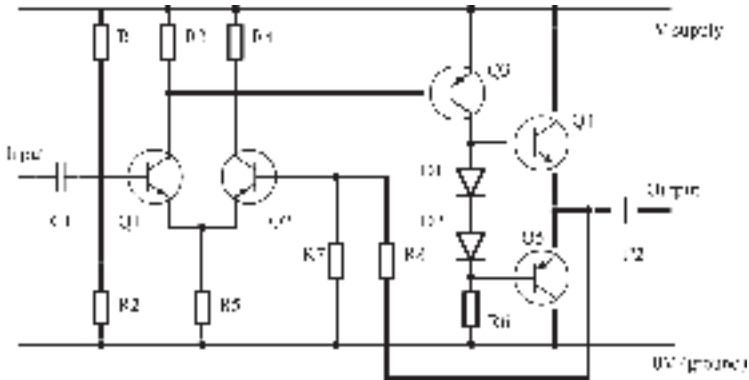


biotechnology, nanotechnology, military, automobile... the list goes on. These hybrid metals are stronger and more durable than the base metals that go into producing them, not to mention way more cost effective.

Without the invention of alloys we would be left deficient in many areas. The invention of the Airplane which also features in this list would have been impossible as there are no naturally occurring metals that can withstand the immense pressures and stresses of high altitudes. With no corrosion resistant stainless steel electronic, agricultural, road and rail industries would have to continually replace resources. We'd find ourselves with large holes in our pockets from having to buy gold in its pure 24-karat form if we didn't have cheaper options courtesy the invention of the alloy.

Amplifiers

Not the amplifiers that give you a headache and make you call the police on your neighbours. These amplifier circuits are quite clever techniques of increasing the signal strength that allow for communication between a tiny microprocessor and the world. They're used at the beginning and end points of all electronic systems to ensure reliable communication. Amplifiers strengthen the power of a signal that needs to be processed by other elements down the electronic circuit. The tiny command from the microprocessor that has a current value of microamperes goes through an amplifier and then to the rest of the circuit. Nothing too complicated,



The study of Artificial Intelligence formally began in Dartmouth College in 1956, as an effort by a group of research scientists to evaluate and mechanically replicate human intelligence. That is, they wanted to program machines to think and respond like humans. Their research was based on the assumption that a machine can be made to simulate learning, reasoning, logic and intelligence demonstrated by humans when given proper description and direction.



Every future invention by man will have its base in AI. Every invention will require an intelligently thinking bot to perform tasks faster and more efficiently than their human counterparts.

Essay grading software, weapons that have minds of their own, Siri by Apple, Kinect the 3D gaming interface, Watson by IBM – formerly a trivia expert machine now used to make decisions on lung cancer treatment and smart CCTVs that can identify crime as it happens: these are the varied and most advanced productions of AI.

February 2013, was the revelation of the world's first Bionic Man – Rex (the Robotic Exoskeleton), complete with artificial organs, synthetic blood and robotic limbs. This one million dollar project is currently on display at London's Science Museum. Rex can walk, hear, make fairly intelligible conversation, etc. This brings up memories of the movie Bicentennial Man and the possibility of human-robot romance overtaking the current human-vampire fad.

Audio Mixing

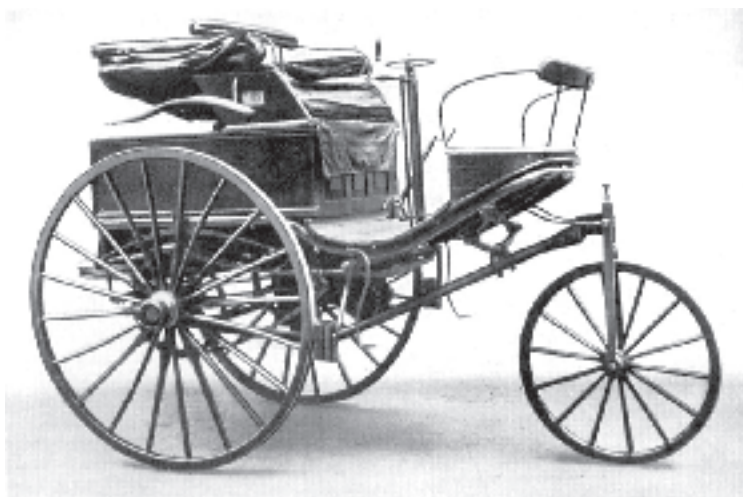
On the face of it, this doesn't sound (pun intended) like that big of an invention. In reality though, it transformed the way music is recorded. Quite literally, the music industry wouldn't be what it is today without it. Audio mixing, simply put, is the process by which multiple recorded sounds are combined into one or more channels such as stereo (2-channel) or 5.1 (surround). Each recorded sound track can

be isolated, enhanced and have even effects such as echo added selectively. Before audio mixing came into the picture, the recording had to be done live with all the musicians present in the studio at the same time. If there was a mistake in the performance the entire ensemble had to perform the song again till everyone got it right. It was the introduction of 8-track recorders during the 1960s that has changed the way music sounds today. Today, many artists can produce high-quality layered music at home thanks to sound editing, which can be done digitally by software programs.



Automobiles

How could we have a list of mankind's greatest inventions and not have the ubiquitous automobile! Much like electricity and radio transmission, the history of the automobile is one that's debatable. You can't really pin down the invention on one person. The first problem in doing so is the very definition of the automobile. If it's simply a self-propelled vehicle then its inventor would have to be Nicolas-Joseph Cugnot who built a steam-powered tricycle in 1769. If we're talking about electric-powered carriages then it would have to be Robert Anderson from Scotland (1839) or French inventor Gustave Trouvé who demonstrated yet another three-wheeled



vehicle in 1881. But most people acknowledge Karl Benz as the inventor of the modern automobile. His invention ran on an internal combustion engine (which he designed and won a patent for). Incidentally the world's first long distance driver was a woman. Bertha Benz, Karl's wife undertook the 106km journey in 1888 to prove the "road-worthiness of her husband's invention". Atta girl!

Batteries

We seem to take batteries for granted these days and barely give them a second thought. This popular electrical device powers a multitude of technologies from laptops to cars and phones to cameras. Since the invention

of the first battery in 1798 by Alessandro Volta, batteries have become a common power source for many household and industrial applications – so much so that the worldwide battery industry generates approximately \$48 billion in sales each year.

Batteries work due to a chemical reaction inside them that causes electrons to flow from the negative to the positive terminal of the battery. When all of the chemicals inside the battery have reacted, the battery is spent. This is true for disposable batteries still in their original packaging as well with each losing 8-20% of their original charge every year simply due to being stored in warm temperatures of 20-30 degrees celcius. The same goes for rechargeable batteries, which lose a percentage of their charge each day when left off the charger and, despite the capability to be charged repeatedly, will eventually die.

The battery is one of mankind's top inventions because it is due to the advances in battery technologies that people no longer have to carry large brick phones and can now operate their smartphones for over 12-14 hours on a single charge.



Binary System

While most of the modern inventions are credited to the western world, the earliest known use of binary system is in the works of the Indian scholar Pingala. Although it's easiest for us humans to count in multiples of tens, electronic machines find using the binary system easier. It's easy because the electric/electronic medium uses the flow of electricity to indicate the 'on/off' state. Assuming the flow of electricity to be 1 and the lack of same to be 0, the electronic machines could be taught how to count using these two digits.

The roots of the binary system can be traced way back to the 'boolean' algebra – created by George Boole (whose

HH : MM : SS



1 0 3 7 4 9

10 : 37 : 49

name you'll come across as a data-type in most programming languages) in 1854. The next major advance was a master's thesis submitted at MIT in 1937 by Claude Shannon who has been called the Father of Information Theory. Interestingly, his paper which concluded that an electrical system based on Boolean algebra would be able to construct and resolve any logical or numerical relationship is said to be one of the most important master theses of all time. Given the fact that everything electronic you can conceive of today works on the binary system, do we even have to try to convince you why the binary system is one of the greatest inventions of all time? We guess not.

Biometric Scanners

Biometrics – turning yourself into an identity card. No need for passwords, ids, pin numbers, etc. All you need is you. It's a move from traditional access control systems to feature-based authentication that provides access based on physical presence rather than token (such as passport or drivers license) and knowledge based (password or PIN) methods.

With advancements in e-commerce and e-transactions, individuals have to retain a large number of passwords, PINs and identity cards. This number will only grow in size with passing time. Passwords and PINs are easy to crack by the right hacker, thus compromising your security. Biometrics couldn't have come at a better time offering the ideal kind of security since no two fingerprints are alike.



The use of Biometric Scanners could unleash an era of super secure gadgets. It is already being used in cars programmed to operate only when a known driver is in the driver's seat, weapons which fire only on detecting the owner's fingerprints and smart household security systems that keep intruders out, among other applications. Not only fingerprints, facial scanning biometric devices are also not rare. Take the Samsung Galaxy S III for example. It has a Face Unlock feature which makes sure that only its owner can unlock the phone.

Fingerprint scanners are the cheapest and hence most commonly used biometric devices. Face and voice recognition follow, as iris and retinal scanning are concepts that most people find intrusive and are not too comfortable using.

The invention of Biometric Scanners was a big step into the future. They've led to the creation of the ultimate unique identifiers – those that cannot be forgotten, changed or lost.

Bluetooth

A wireless technology used to exchange data over short distances using short-wavelength radio transmission, Bluetooth was created by Ericsson in 1994 as an alternative to data cables. The term “Bluetooth” is an anglicized version of Blatand, the epithet of 10th century Danish king Harald who united separated Danish tribes into a single kingdom. The technology was named after him as Bluetooth does what Blatand did but with communications protocols – unites them into one universal standard.



Since its introduction, Bluetooth has increased in popularity over the years – while in 2008, only 5% of mobile devices were Bluetooth-enabled, in 2013, roughly 95% of mobile devices support it. Also, while traditional Bluetooth devices only worked within a range of 10 feet of each other the newest versions now enable transfers to a distance of up to 100 feet. However, what makes Bluetooth stand out as a form of wireless data transfer is that it uses very little power, can be incorporated into a wide variety of devices and can have up to eight devices communicating with each other at once and automatically without a user's prompt.

We all know how amazing it is that Bluetooth enables us to print wirelessly, talk hands free and mirror the content from our mobiles to our TVs

wirelessly; but, stay tuned as this wonderful technology is now being adopted for use in medical equipment as well. Analysts predict that one-third of all new cars globally will have in-built wireless Bluetooth connections – one can only wonder what's next.

C Programming Language

Back in the early 1970s, Dennis Ritchie and Ken Thompson were building the first UNIX operating system on a machine called PDP-7 and needed to port the OS to run on a better machine called PDP-11. Existing languages couldn't help with this task due to their inability to cope with the PDP-11's advanced hardware features. As a result, C was created.

Back in those times, kernels were written entirely in assembly languages. Writing code in assembly language needed the programmer to understand the entire platform, especially the processor. Also, it was time consuming, confusing and arcane. The mid-level nature of C allowed programmers to use advanced hardware features while not having to deal with assembly. This made it one of the first high-level programming languages which could also be used for low-level tasks. Later, C was used to rewrite large parts of the UNIX kernel. UNIX played a huge role in the development of computing and inspired many other operating systems including Linux and BSD (Mac OS X was based on FreeBSD originally). Even to this date, they belong to the UNIX-like OS family!

C was later built as a portable language which could be adapted on various platforms and has ever since stayed in vogue. C++, a superset of C programming language is just as powerful and brings in object-oriented programming to C, enhancing the power of C. After sophisticated Java came along, C was demoted and began to be called a mid-level programming language. While its usage has dropped due to many other languages coming in the picture, a lot of high performance tools and applications are still written in C/C++. Some of these include operating systems, databases, games, server software and desktop applications. Even iOS apps are written in C.

Camera

While applying the 'brush filter' is a cool way to make your pictures look artsy, there was a time when brushes and paint were the only way to capture scenes. It would take hours before someone with the right skills could capture the right moment. One of the first ever cameras built was called Camera obscura. Interestingly, it could not take pictures but served as a



device which aided in drawing pictures. In 1826, one of the first pictures was photographed using a metal plate. By 1885, photographic films came into being and the first camera went on sale in 1888; it was called Kodak. The rest is history. Developments later here we are today with CCD technology fitted behind tiny eyes on mobile phones.

The camera is arguably one of the most exciting and important inventions ever. Cameras gave birth to the phenomenon of being able to record events. News channels had more evidence when presenting stories, as they unfolded. Explorers could record what the deepest of caves and farthest of stars looked like. Without a camera, entertainment would still be served to us the old fashioned way – on the radio! You wouldn't have television shows and movies to enjoy or memories to relive. Instead you'd probably have to invite musicians and dancers to your home and have them perform in your living room. Who knows the importance of good pictures better than Digit. A picture says a thousand words, which helps us free up space and serve up more content – everyone's a winner thanks to this invention.

Capacitors

A capacitor is an electronic device that has the capacity to store charge. It's one of the most basic elements used in electronics. Its invention was kind of the result of a discovery. In 1745, after his hand suffering a terrible spark German Physicist, Ewald Georg von Kleist discovered that a hand-held jar



could store charge after disconnecting it from a high voltage electrostatic generator. It was only much later understood how the glass jar that had a film of metal on the inside and outside worked as a capacitor after being charged.

The capacitor earned its popularity when the invention was taken advantage of by Faraday when he wanted to store the electrons of his experiments. The capacitor is now an essential part of almost every electronic circuit. Its most obvious application is storing energy as in batteries and its property of storing charge has been used to implement data storage. To know how the capacitor works from this brief would be a tad high expectation but it would suffice to say that the capacitor is essential and atomic to electronics.

Cloning

The first instance of cloning most of us heard about was probably Dolly the sheep in 1997. However, cloning technologies have been around since almost a century before that. The first animal to be cloned was a sea urchin in 1885. And this was done by simply shaking apart the embryonic cell to create two identical cloned cells which later developed into identical sea urchin embryos.

In biology, cloning refers to creating identical copies of individual creatures, while in biotechnology it refers to creating copies of cells or DNA fragments.

The human body has natural healing abilities that can be awoken by injecting an extracellular matrix (ECM) like pigs bladder at the site of an



injury or damaged tissue. This essentially has the potential to give us X-Men like healing abilities.

The reasons for Cloning featuring in this list of inventions are myriad. Producing disease resistant plants, saving animals from extinction, solving world hunger crises and therapeutic cloning for organ transplants are just a few examples of its potential scope.

Hundreds of animals have been cloned to date by methods called “nuclear transfer technology”. However, during the process many unsuccessful attempts resulted in death of the animal due to infection.

Of course, cloning gives rise to many ethical and moral dilemmas especially when we talk of cloning humans. So far it has been a topic only dealt with by sci-fi movies but at the rate science and technology are progressing the day doesn't seem far when there will be clones walking amongst us.

Compass

The compass was invented by the Chinese in so-long-ago BC, but it wasn't used for navigation until later. The Chinese, famous for practising Feng Shui, used the compass as an accessory for the purposes of spiritual life. Lodestone, a naturally occurring magnet was used by the Chinese fortune tellers in their craft. Before the invention of the compass, astronomical knowledge of stars and the Sun was depended upon by travellers to determine position and direction. Soon it was discovered that lodestone aligns itself along the magnetic north/south axis of earth, and the first magnetic



compasses were made for navigational purposes. Long back, the compass was known as the “matsya yantra” in our country, because the device consisted of a metallic fish (from an early Chinese design) placed in a cup of oil; the oil was used to make the magnetic needle settle quickly. However, the early compasses didn't really help Columbus in his voyage when he landed at West Indies instead of India. It was found that the true geodetic north (the North Pole) is different from the magnetic north (in northern Canada), as pointed out by the magnetic needle. As time passed, better, more accurate and purpose-specific compasses were made. Gyrocompass is a non-magnetic compass that finds the true north. It's similar to the gyroscope, in that it uses a (electrically powered) fast-spinning disc and friction forces due to rotation of the Earth. This type of compass is mainly used on ships as it's not affected by ferromagnetic metals. Today we use our smartphones to give us directions, possible due to in-built magnetometers. It provides data to the microprocessor and directions are calculated using trigonometry by internal electronics.

Data Compression

If you're an ardent photographer you've probably noticed the option your camera offers of saving photographs in RAW format. That means you're using a format that retains the image in excruciating detail. Many formats have been developed considering the sensitivity of human perception to do away with excruciating detail that only go on to hog space in terms of MB and GB on your memory stick. To reduce the cost of storing images in



electronic memory certain standards like JPEG and MPEG were developed. JPEG, if you didn't know, is short for Joint Photographic Experts Group and MPEG stands for Moving Picture Experts Group.

What compression essentially does is loses superfluous information to trim the size of the file. How it does this is through different algorithms such as Lempel-Ziv, Huffman Coding and Discrete Cosine Transform to spot the repetitive and unnecessary details. For example the photograph of the sky would have hues of approximately the same shade. So the compression technique spots the pixels with approximately the same information (colour) and flattens this repetitive information by reducing the slight variations. This reduces the cost of storing the image because it occupies less space and because the lack of variations are not perceptible to the human eye the idea of compression is quite clever.

Databases Management Systems

Not just philosophically, change indeed is the only constant. If you know a bit about programming, you'd also know how difficult it can be to design a storage structure only to realize later that it was imperfect and that improvements are needed. You might want to start using a database to solve the problem. But there was a time when they weren't around.

Databases can be said to have been developed in three stages. The first stage was the dawn of navigational databases in which the application would follow links or references to reach the final data. The second stage was the development of relational databases which stored data in rows and columns. Relational databases made more sense since they allowed the applications to search for data instead of following references and were better in terms of application growth. To this day, the relational model happens to be the most popular one. Oracle, Microsoft SQL Server, MySQL and PostgreSQL among others are all relational DBMS. The third generation of databases is called post-relational databases. The current generation of NoSQL DBMS such as MongoDB, HBase, Cassandra, Redis and CouchDB fall in this category.

Databases, especially relational ones, freed the programmers from having to take care of data storage and search so that they could focus on algorithms and features. Without databases, the time taken to develop applications would be at least 10 times greater. Database management systems also eliminated language dependencies as the data saved by a program written in one language (say C) could be read by a program written in another language (say Java). This decoupling



of data storage layer later gave birth to the dynamic web applications we're all so fond of.

Diffie-Hellman Key Exchange Algorithm

When the era of the internet, email and online messaging began, preventing sensitive information from going astray increasingly became important. With this context, the invention of public key cryptography was a pivotal one to ensure the safety, security and integrity of any information transmitted digitally. For making this possible, we have a lot to thank Whitfield Diffie and Martin Hellman – two pioneers of public key cryptography – for.

They devised an ingeniously simple method in the form of an algorithm to ensure a message or conversation between two parties remains confidential. This algorithm uses arithmetic modules as the basis of its calculation. In this method, two parties that have no prior knowledge of each other collectively establish a shared secret key over an insecure channel of communication. They can then use this key to encrypt the communication henceforth using a symmetric key algorithm (type of algorithm which uses the same cryptographic keys for both, encryption and decryption). The beauty of this technique is that the shared secret key is not protected from interception but it is protected from modification. This algorithm is extremely simple when it comes to its concept but has a very high level of cryptographic stability which is actually due to its mathematical complexity.



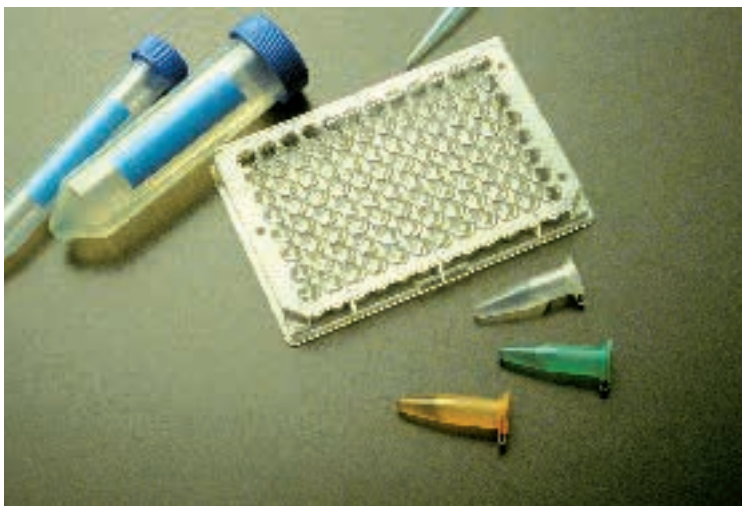
Password Authenticated Key Agreement (PAKE), a form of Diffie-Hellman is used to prevent man-in-the-middle attacks which is like eavesdropping. Other variants of Diffie-Hellman, such as STS (Station-to-Station Protocol) may be used instead to avoid these types of attacks in an efficient manner. So in a way the Diffie-Hellman algorithm is the basis for currently used cryptographic techniques since this algorithm worked very well when generating cryptographic keys to encrypt data communicated over a public channel.

DNA Fingerprinting

Invented accidentally by Alec Jeffreys when he was studying gene evolution, much to the delight of the CSI television show. Its first use was in confirming the identity of a British boy whose family was originally from Ghana. Jeffreys realised the enormity of what he just invented and so he left whatever he was doing and went head on into research towards other applications of DNA fingerprinting.

Since about 99% of the DNA is identical in humans, the variable part is assessed; this uniqueness is the base of DNA fingerprinting.

The first use of it in a criminal investigation was in the case of the murder of two girls. A Richard Buckley was arrested for the murder of both the girls but had confessed to only one. Using DNA fingerprinting the true murderer of the second girl was caught.



The Shoah Foundation, an Institute for Visual History and Education, is working on building a database using DNA fingerprint to re-unite families who were separated during the holocaust.

It has been called “the most powerful crime-fighting tool we have at our disposal” right now, so its effectiveness can be easily vouched for; unless you’re twins born through one sperm, in which case the DNA fingerprinting process gets confused and just picks the first one it finds.

Dynamite

Dynamite is a high explosive, invented by Swedish industrialist, engineer and inventor, Alfred Nobel in the 1860s. The explosive is based on nitroglycerin, the manufacture and transportation of which was very hazardous because it was highly volatile. Alfred mixed it with silica and created a malleable paste called dynamite; Nobel originally sold it as “Nobel’s Blasting Powder”. It was safe to handle without the danger of it blowing up unintentionally. Dynamite consists of sawdust (or any other absorbent material) soaked in nitroglycerin, compacted into a cylindrical shape and covered with a protective coating, and a blasting cap with an electrical cable attached to it. Unlike what’s shown in most cartoons, dynamite wouldn’t blow up when a flaming arrow lands in a case of dynamite. In fact, it won’t even explode when set on fire if it gets damp. Dynamite needs to be detonated to make it explode. A detonator would be stuck into the dynamite which would explode with an electrical charge and this initial explosion would then explode the dynamite. Alfred Nobel also

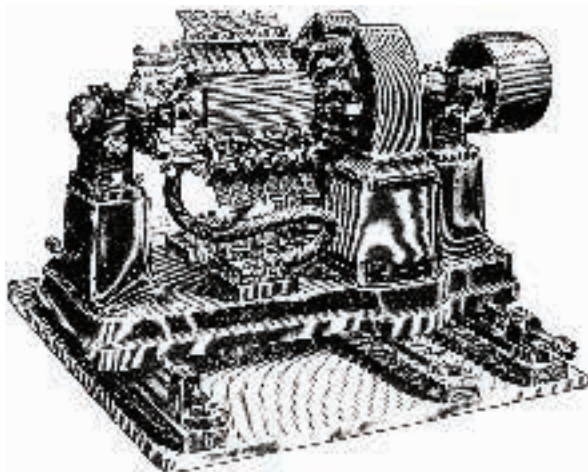


invented this detonator. Shouldn't he get a Nobel prize for all this? A stick of dynamite (0.19 kg, 75% nitroglycerin) contains around 1 million Joules of energy, enough to blow up your car. Dynamite has been increasingly replaced by Semtex and C4 for military usage. It's still used for blasting gold and diamond mines in South Africa.

Dynamo

A powercut for a couple of hours is enough to frustrate the living daylight out of us. Well, then try and imagine life without usable electricity. Thanks to Michael Faraday and his law of induction today we live in a world where generation and usage of electricity is fairly straightforward. We owe this to the invention of the dynamo. The word "dynamo", derived from the Greek word for power, is now used to refer to an electrical generator that produces direct current with the use of a commutator. The dynamo, like any other generator is used to produce electricity from mechanical energy. The first dynamo however, was invented by Michael Faraday in 1831; it didn't use a commutator and generated DC current producing very low voltages.

However, Tesla's theory that the future of electricity lied in AC (Alternating Current) rather than DC – as thought by his rival Edison – turned out to be right. This effectively doomed the dynamo to minor science experiments. Dynamos were quickly replaced thanks to the inefficiencies of the commutator, and because converting AC to DC was a more effective



and economic method. However, the invention of the dynamo was a game changer in the history of electricity. It was a simple device which laid down the foundation upon which more complex devices currently in use, such as the electric motor and the alternator were based. The dynamo was the first commercially useful electric generator, and it led the first steps into the use of electricity in industry, and thus its importance as an invention in the history of mankind cannot be questioned.

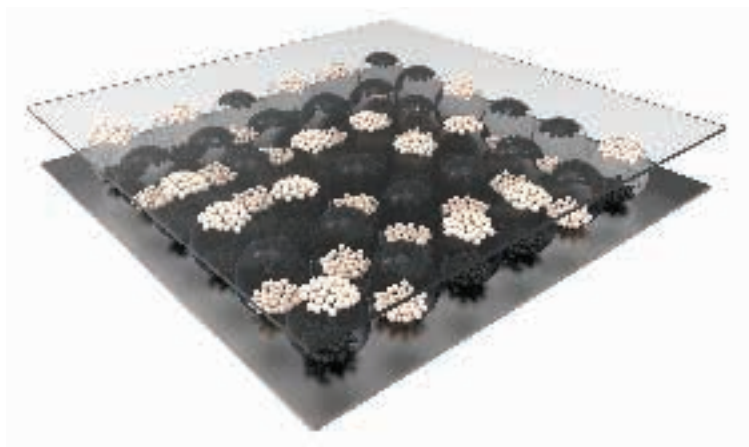
E-ink

Developed by the E Ink Corporation, a spin-off of MIT Media Lab, the E-ink technology is used in e-readers such as the Kindle and the Nook.

Electronic ink is made up of tiny capsules, each of which contain positively charged white particles and negatively charged black particles suspended in a clear fluid. When a positive or negative electric field is applied, the respective particles move to the top of the capsule where they become visible to the user, resulting in the surface appearing white or black at that spot.

One of the other features of e-ink is that it uses Bistable technology. What this means is that the image on the screen will be retained even if the power is removed, because it only consumes power when turning to a new page, or a new image. So you can take as much time as you want to read your Kindle if the battery is low, but don't you turn that page!

While there have been some criticisms of the e-ink technology being friendlier to the eye because of the absence of a backlight, that is the largest



cited reason for using e-readers. The only downside is that when you read your famous controversial book on the bus, that pretty girl seated next to you won't have a conversation starter because she won't know what you're reading – unless you stick the cover of the book on your reader, which frankly is pretty weird.

Electric Guitar

Called the Frying Pan, probably due to its shape, the guitar pictured here was the first version of the much loved electric guitar. It was the result of a long and arduous struggle by George Beauchamp (in collaboration with Adolph Rickenbacker) who wanted a louder, improved guitar, even going as far as attaching a Victrola horn (the horns you see attached to classic record players) to the bottom of the guitar and pointing it at the audience, in vain.

Unfortunately for George, in 1931 there was no way to patent a musical device which was also electric – it was either one or the other, resulting in many other sneaky companies duplicating the device. Unfortunately again for him, George died of a heart attack while deep sea diving in 1940, and didn't live to see what has come of his creation. Later, Les Paul mounted strings and pickups on a solid block of pine and thus was invented the first solid body electric guitar.

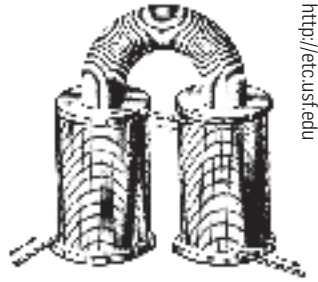
We find this to be a really important invention because without it we



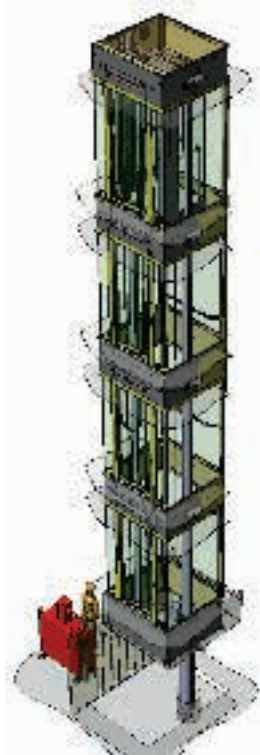
would have lost the cornerstone of rock, the air guitar. That, and the fact that it fueled some pretty obscure genres such as rock n roll, jazz and the blues.

Electromagnet

Your doorbell, car and electric guitar all have one thing in common, an electromagnet. Invented by William Sturgeon in 1825, it simply consists of a copper (or any other conductor) wire wound around an iron core and connected to a battery (source of electricity). When current passes through the wire, it magnetizes the iron core temporarily while it is running. Turns of copper wires carrying current without a core will also work as a magnet, but when wound around a ferromagnetic material such as soft iron creates a stronger electromagnet. Sturgeon displayed its power by lifting about four kilos of metal with a 200g iron core electromagnet. The wrecking yards use electromagnets to lift and move heavy pieces of scrap metal, even entire cars. A couple of years later after its invention, American scientist Joseph Henry used it for long distance communication by sending current from a mile away and causing the electromagnet to strike a bell. Thus the electric telegraph was born. The advantage of electromagnets over permanent magnets is that their magnetic field can be controlled by varying the amount of current. Therefore they're used to make controllable machines such as motors and generators. They're also used in loudspeakers to amplify the sound.



<http://etc.usf.edu>



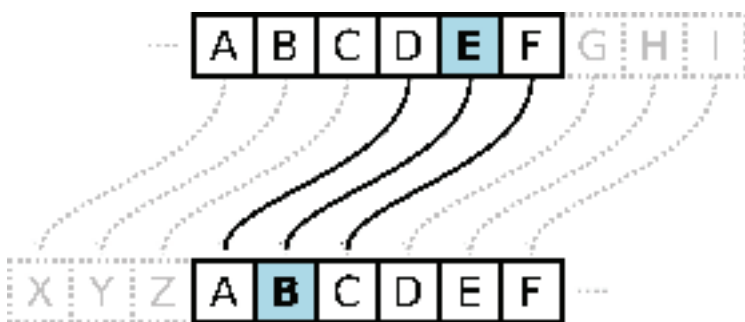
Elevator

The invention of elevators is probably the major cause of obesity in the world. Commonly known as lifts, they've been used for "lifting" people,

goods and any tangible item between floors or levels of a building since as far back as we can remember. Primitive elevators were operated by humans, animals or water wheel power. In early 19th century steam-driven elevators were used in England. Later, hydraulic elevators replaced these. The hydraulic elevator is supported by a heavy piston, moving in a cylinder, and operated by the water (or oil) pressure produced by pumps. In 1853, Elisha Graves Otis created the brakes used in modern elevators which paved the way for skyscrapers. Italy is the nation with the maximum number of elevators, followed closely by the United States of America. The future of elevators is not however limited to Earth. The concept for a space elevator was first published in 1895 by Konstantin Tsiolkovsky. A space elevator (or beanstalk) is a proposed type of space transportation system. The futuristic structure from sci-fi movies would consist a ribbon-like cable (a.k.a tether) anchored to the surface near the equator and extending to space beyond the geostationary orbit. But again, it's a long way to go before this idea can reach fruition.

Encryption

While 'hacking' is now used interchangeably to mean 'computer hackers', confidential data and private messages have been intercepted since the beginning of civilization. Encryption, the art of scrambling data to ensure its readability by only the intended recipient is not a new concept. If you went through the FastTrack on Cryptography we published last year, you'd probably already have detailed knowledge about how this works. Encryption doesn't fall in the classical category of invention since it's a concept, not a tool one could touch and feel. It didn't find widespread use



until about a decade back when [https](#) started becoming a part of our lives. But if you went back in time, you'd realize how it has saved millions of lives. It has won wars, old and new. Encryption techniques saved great civilizations like Rome from falling victim to attacks. It helped spies to report to dynasties and armies to carry out confidential orders. Though it may sound melodramatic, if there were to be accreditations on what helped humanity survive and prosper to this extent, encryption would be on the list. Had it not been for cryptography, and in turn encryption, the world would have seen more carnage than it did. To this day, it protects us from malicious attacks on our files and network connections and continues to help maintain our privacy.

Fibre Optics

Light reflects back off medium boundaries when the target medium is less dense than the source medium and the angle of approach (incidence) is greater than the critical angle for total internal reflection. That's high school physics. Contrary to most lessons taught in school, this one serves as one of the biggest game changers of our times. Built on this simple theory is one of the fastest mediums of data transmission of this age – fibre optics.

Downloading wallpapers and music over your DSL connection is one



thing; managing such downloads for millions of users is another. When data speeds are beyond what a single desktop PC would normally be able to process, copper wires don't serve well. This is where fibreoptics come in. Fibre optics work on the theory of total internal reflection and are much faster than the traditional medium of data transmission. This is because of the medium itself, viz light.

Optical data transmission promises the highest transfer rates with least noise and power loss. Both these properties make fibre optics THE data carrier medium for inter and intra-continental networks. Apart from being used in backbone networks, fibre optics are used within data centres to connect computers which need to serve as much data as possible. Since disk speeds are usually much faster than traditional electric wire based networks, they don't do justice to the hardware capacities of these machines. Hence, fibre optics!

Flash Memory

The amount of data we own is growing at an alarming rate. It needs to be stored somewhere secure and portable. Flash memory devices do just that. Flash Memory is a form of non-volatile memory. It can be arranged and reprogrammed at will. Data in it is arranged in units called blocks.

The concept of flash memory was developed at Toshiba by Dr. Fujio Masuoka in 1980. The term 'flash' was given as this sort of storage is easily and electronically erasable. There are two types - NAND Flash memory and NOR Flash memory, the difference lying in interface for reading and writing to the device.

Flash memory is used in cameras, cell phones, LAN switches, set-top boxes, embedded controllers, MP3 players and a variety of other devices.

It was not so long ago we were using CDs and floppy disks for data storage and transfer. Inerasable and bulky, they were the only option at the



time. But now, pen drives and memory cards ensure that storage options are reusable and as tiny as they can get. The future of flash memory holds tremendous possibility. As with electronics, smaller is always better. Currently the smallest flash memory disk is a SanDisk 128GB measuring just 19nm. With traditional methods of data storage we used to worry about how and where to store the disks, damage that could occur to them and how to dispose of old data. Now the only concern is that we might misplace the drive because it is so small.

Float Glass

Before the advent of Float Glass, flat panels of glass were cut from very large cylinders of blown glass that were cut open and flattened. In this way, large sheets of glass weren't really possible and besides, the glass made this way was very uneven – distorting view considerably. They were expensive as well. Along came Sir Alastair Pilkington, a British engineer who got the idea of floating molten glass on a bed of low-melting-point



molten alloys, usually Tin. The glass that resulted was flat and of uniform thickness, and so had no weird refraction. The first sheets of float glass were made in the '50s and today most glass is of this kind.

FPGA

Although this may sound like just another geeky acronym to you, the importance of FPGA can't be stressed enough. Invented and patented

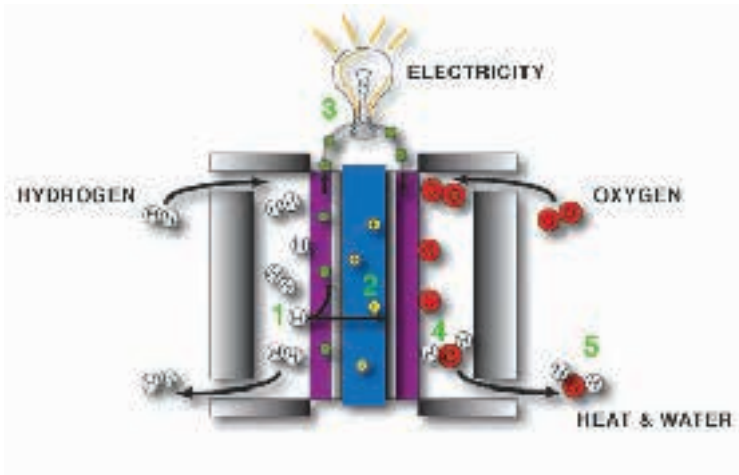
in the mid-1980s, field programmable gate arrays quickly exploded in the telecommunication and networking sector in the '90s. FPGAs continued to be in demand for anything to do with a digital circuit and were welcomed with open arms in the field of consumer tech and automobile manufacturing. FPGAs were the new kid on the block and remain instrumental in fields ranging from medical imaging to radio astronomy and everything in between.



Think of them as integrated circuits that can be re-programmed on-the-fly in a jiffy, great for prototyping semiconductor devices or testing “logic function” before perfecting them for large scale deployment. It has literally helped companies in the electronics manufacturing segment save billions of dollars – at the same time, helping Xilinx (who invented FPGA) mint billions itself. FPGAs are seeing increased application in the development of SoCs (used in latest smartphones and tablets; they’re also on the radar of Bitcoin miners trying to generate more virtual currency). FPGA’s demand is only going to rise in the near future. Why? Intel (the largest semiconductor manufacturer in the world) and Altera (the second largest producer of FPGAs in the world) recently signed a deal which lets Altera produce insanely better, never before seen FPGAs using Intel’s tri-gate transistor 14nm process. So watch out, uber cool FPGAs are coming to change your world forever.

Fuel Cell

A fuel cell uses chemical reactions to convert energy from a fuel such as hydrogen to electricity in the presence of an oxidizing agent. Unlike batteries, a fuel cell can produce energy as long as the raw materials are supplied to it. Speaking of raw materials, apart from hydrogen a fuel cell can also use hydrocarbons such as natural gas and methanol. It is generally believed that Sir William Grove invented the first fuel cell in 1839, while it was a German scientist, Christian Friedrich Schoenbein who first noticed the fuel cell effect. What they were trying to do was reverse electrolysis (a processes by which water is split into its founding blocks – hydrogen and oxygen – by passing electricity through it). Once the process is reversed,



you could potentially generate electricity and water as a by-product. The process is simple: an anode and cathode are inserted into an electrolyte. The electrolyte allows charges to move between the negatively and positively charged sides. The anode and cathode are connected by an external circuit and electrons travel from the anode to the cathode producing current. The fuel cell was hailed as a great invention, however at that time (and this was a time when discoveries were more common than Bieber fans amongst school girls), the dynamo received more public attention. Years later researchers Ludwig Mond and Charles Langer attempted to make a more practical model and coined the term. Today, clean energy companies such Bloom Energy (founded by Indian KR.Sridhar) are producing sizeable amount of power for tech giants like Google thanks to this invention.

Gatling Gun

The invention of the Gatling Gun, the forefather of the modern day machine gun, was perhaps the greatest turning point in the history of warfare. Ironically, the Gatling gun was invented in an attempt to save lives, rather than take them. Dr. Richard Gatling noticed that the reason of the death of a majority of the soldiers in the civil war was illness, and not gunshots. So he invented a machine which could enable one man to do as much battle as a hundred, thus reducing the number of people required for war, in turn reducing the number of casualties. His goal wasn't completely unsuccessful. Even though the number of lives the Gatling gun took in the civil



war were aplenty, it also saved many lives owing to the lesser number of personnel posted on the field.

Gatling, while experimenting with improving the gun, developed an electric motor which could power the gun, which gave birth to the minigun. Even though the Gatling gun was deemed obsolete way back in the early 19th century, miniguns went on to be widely used on airplanes and helicopters starting much later in the 1960s. Considered the first successful rapid fire gun, the Gatling gun was the prototype that has since evolved into various different models of the machine gun, which are still widely in use today. For changing the face of modern warfare, the Gatling gun is definitely one of the greatest inventions of mankind.

Gears

What would it be like if you kick-started your motorbike and it always ran at a uniform speed? To begin with, it would be boring. In addition, there's the disadvantage of decreased fuel efficiency and inability to ride up heights. Thanks to gears you can adjust speed and make sure your vehicle is able to make the most of the precious fuel in its tank. But that's just

one of the several uses of gears. Gears are used when one needs to control the speed or torque of a moving element.

A gear is a rotating machine part which has teeth-like cuts on one of its rotatable sides. When two or more of these parts work together (see picture), the system is called a transmission. Gears are analogous to pulleys, however they



have an added advantage – gears prevent slipping because of their teeth-cut design. The most popular and commonly seen example of the gear is the Spur gear used to adjust rotational speeds. Other types of gears transform the direction of motion as well. An interesting ‘Sun and Planet’ gear system was used by Scottish inventor, James Watt on his early engines instead of a crank system for power transmission.

Most modern day transport vehicles employ gears to make the best use of the power they generate by burning fuel. Without gears, journeys would have been slower, inefficient and quite costly. Interestingly, compact engines inside high-speed rides ranging from bikes to planes are benefitted heavily by gears, without which they would be huge, unreliable, inefficient, and once again, costly.

Geiger Counter

Geiger Counter is an instrument that detects and measures the intensity of radiation. It's a metal cylinder filled with low-pressure gas sealed by a plastic or ceramic window at one end. A thin metal wire made of tungsten runs down the centre of the tube. This wire is connected to a high, positive voltage resulting in a strong electric field between it and the outside tube.

When radiation enters the tube, it causes ionization, splitting gas molecules into ions and electrons. The negatively charged electrons get pulled by the high-voltage positive wire and as they zoom through the tube collide with more gas molecules and produce further ionization. The result



is that lots of electrons suddenly arrive at the wire, producing a pulse of electricity that can be measured on a meter and heard as a “click” (which translates to “trouble”).

In 1912, Hans Geiger along with John Mitchell Nuttall formulated the Geiger-Nuttall Rule, describing the linear relationship between the radioactive time constant and the logarithm of the range of alpha particles. To get more accurate readings, in 1911 Geiger invented a device to count radioactive alpha particles automatically in normal light. This was the original Geiger counter.

Unfortunately with the outbreak of war in Germany, Hans had to go serve as an artillery officer with the German army. Here he met Walther Muller, with whom he collaborated and improved on his previous version of the Geiger Counter, now called the Geiger-Muller Counter.

Today a geiger counter is used to detect radiation in food, test for danger in a nuclear reactor and detect radioactive rocks and minerals while prospecting. Imagine living in a room for a year and then finding out that an arm is growing out of your back. You can't? Thank Mr. Hans for that.

Gunpowder

This chemical is a product of our “have fire, will burn” mentality. Rumoured to have been discovered in the 6th century B.C. by Chinese alchemists who were on a quest to discover the elixir of life (which somehow led to the



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discovery of the ultimate recipe of death), this compound has reshaped the world in more ways than we know.

Who would have thought that a simple combination of sulphur, charcoal and potassium nitrate would lead to the creation of the single most destructive compound known to Man. Gunpowder isn't even the best or most powerful explosive. It's quite simply a subsonic explosive with a comparatively low burn rate and limited power output. This was the ideal explosive for use in handheld firearms simply because it had sufficient power to propel a projectile at supersonic speeds without damaging the weapon or its wielder. It's ironic that without war, this compound would have no reason to exist, except in fireworks.

Gutenberg Press

Arguably, nothing has contributed to molding society into its current state, more than books. Books are the greatest source of knowledge and definitely the building blocks of civilization. Therefore, the invention that is responsible for the existence of books in the first place, definitely deserves a mention in this list. The Gutenberg press made by Johannes Gutenberg was a movable type printer that enabled him to produce thousands of copies of the same page. In 1450, Gutenberg embarked on his most important project – printing the Gutenberg bibles. These are widely regarded as the first books to have been printed in Europe and the first Bibles ever printed. His printing process including the use of metal molds and alloys, with some refinements, remained the main method of printing for over 500 years.



Words that are spoken are barely remembered, whereas words that are written thrive and multiply. The Gutenberg Press, thus allowed the sharing of knowledge and enabled the immortality of wisdom passed down over the ages. It was responsible for the spread of literacy among the masses, and thus responsible for most of the major developments – scientific, academic and political – in the history of mankind. To top it all off, this invention is the reason you get to read this absolutely wonderful magazine with the most amazing articles.

Gyroscope

Invented in 1852 by Leon Foucault, and with a prototype developed by Johann von Bohnenberger in 1817, the gyroscope is capable of magic. Really.

A gyroscope can balance itself on a string or a finger, and resists falling down even when in very odd positions. This effect is said to be because of a combination of angular momentum and torque. When the ring inside spins, a force is generated which acts perpendicular to the spin of the disk. This is what keeps it up and a resultant behaviour called ‘precession’ is



the reason why when you google gyroscopes you'll see wheels spinning at odd angles when dangled on a string.

The word 'gyroscope' from the greek word *gyros*, meaning 'circle' because the device demonstrates that the earth rotates and *kropos* meaning 'watcher'.

Take two gyroscopes with their axles at right angles to one another on a platform. Place this platform inside a set of gimbals (a gimbal is a pivoted support that allows the rotation of an object around a single axis.). The platform should, unless you did something odd, remain completely rigid as the gimbals rotate freely. You've now developed the basis of the inertial navigation systems (INS), used in ships, aircrafts, submarines, guided missiles and spacecrafts.

Hard Drive

Created by IBM in 1956, the first hard drive – a popular data storage device – was made from 50 24-inch discs contained inside a cabinet that was as large as a cupboard! The whole thing had a whopping capacity of 5 MB and could only be leased at a cost of \$3,200 per month. The first commercially

available hard drive called ProFile was sold by Apple in 1981 for \$3500 – that's \$700 per GB!

While hard drives became popular for widespread use in computers and later as external data storage devices, it may be news to you that even calculators, cash registers and VHS machines utilise hard drives to store varying amounts of data. This device is important because the size and speed of the hard drive in a system is directly proportional to how efficient the system will be.



What makes hard drives revolutionary is their infinite ability to be rewritten unlike traditional storage devices such as disks and tapes. Because the information is stored magnetically all the data can be rearranged, changed and moved around without disruption or loss of data. It actually took 51 years since the hard drive was first invented for disks to reach a capacity of 1 terabyte. This happened in 2007. Following shortly was the first 2TB storage hard drive in 2009. One can only wonder what the next level of storage will be and how soon it will come to the market.

Harnessed Electricity

Electricity as a potent force has been looked at in wonder since time immemorial. Even in ancient times there are records of wool being rubbed to generate a spark of static electricity. But the history of electricity being used as a viable energy source is a chequered one. In 1752, Benjamin Franklin conducted the famous kite experiment to show that lightning is indeed electricity. Towards the end of the 18th century Galvani discovered bio-electricity and even inspired the now famous Frankenstein legend. But the idea of harnessing electricity can be traced back to Faraday's seminal work in inventing the electric motor in 1821 and Faraday disk in 1931. But the principle of converting current to mechanical force and vice versa couldn't have been possible without discoveries made by André-Marie Ampère and Alessandro Volta (Notice their names). In experimenting



with more winds in the coil to produce better voltage, the dynamo was invented in 1832 by Hippolyte Pixii and it became the first viable industrial source of harnessed electricity. (Check out the entry on Dynamo for more details). The battle for harnessed electricity also saw the great Tesla vs. Edison fight over whether direct current or alternating current would be the way forward (at least in transmission).

HTML(Hypertext Markup Language)

It's used to create documents on the World Wide Web. Tim Berners-Lee was the primary author of HTML (developed in 1990), assisted by his colleagues at CERN. HTML is used to design a web page to be displayed in a web browser. The web browser reads the HTML code and displays the content. The code is written in the form of tags (like <tag>) with attributes. It allows images and objects to be embedded to create interactive web pages. HTML documents are usually delivered by HTTP from a web server. There are some WYSIWYG (What You See Is What You Get) editors, which allow you to lay out the design of your web page using GUI and the editor creates the corresponding code. The fifth revision of HTML, HTML5 keeps up with the new multimedia technology and is mobile friendly. HTML5, supplemented with CSS3 and Javascript does away with (previously required) external plugins like Adobe Flash or Microsoft Silverlight. The World Wide Web Consortium (W3C), which was also founded by Tim Berners-Lee and is currently headed by him, is the main international standards organization for the World Wide Web.



Hybrid Cars

The two primary concerns that the invention of the Hybrid car has addressed are increasing pollution levels and the rising price of fuel.

Hybrid Vehicles are those that use multiple power sources to operate the vehicle. Hence any car that runs on two or more sources of power can be called a hybrid. Most use a rechargeable energy storage system to sup-



plement or totally replace fossil fuel energy for vehicle propulsion. Hybrid engines are smaller and more efficient than traditional fuel engines. Some hybrid vehicles use regenerative braking to generate electricity while travelling.

The first hybrid car invented was called the 'Mixte' and developed way back in 1902. It was invented by none other than Ferdinand Porsche founder of Porsche. The first commercial hybrid car was the Toyota Prius in 1997, made in Japan.

Hybrid cars produce 90% less pollution than other vehicles. The combustion engine itself generates electricity for the vehicle to charge so there is no need to 'stop and plug in' like electric cars. The depreciation of hybrids is also slower making them more cost effective. Repairs don't cost much and some governments even encourage the purchase of these environment friendly vehicles by offering tax rebates and other incentives. Performance wise Hybrids run at 50-60 miles per gallon, essentially using only a third of the fuel that a conventional vehicle would.

The invention of the Hybrid car has ensured that you can travel safely, at lower cost, with better mileage and a smaller carbon footprint.

Infrared

Who'd have thought of measuring the temperature of light. But that's how Sir William Herschel discovered infrared rays in 1800. Also known as thermal rays, they are beyond the visible range, below the red side of the spectrum (hence the name).



Probably the most common application of infrared rays is in the remote control, saving humanity the trouble of having to get up to flick channels on TV. They're also extensively used in mice, the ones connected to your PC, not the rodent variety. Its other applications are in the field of medicine, space and communication amongst several others. They are extensively used in night vision equipment to gauge distances, detect motion, and to increase

visibility in fog. Infrared equipment is used by the police and military as well as in fire fighting to enhance visibility. They are used in spectrometers used to test and study electronic systems.

Infrared imaging is used by satellites to monitor the weather, vegetation patterns, ocean temperatures and several other applications in astronomy.

Inkjet Printer

There is no clear inventor as such of the inkjet printer although rumours point to an IBM technician named Steven Sears. It was invented in 1978, and in 1988 Hewlett Packard released the Deskjet Printer as a home consumer item for a whopping price of \$1000.

An inkjet printer places small droplets of ink onto paper to create an image, and its advantage was that it sprayed ink only when necessary and so, overall, was not very expensive.

The early inkjet printers focussed only on affordability, not quality, and so were able to print low quality black and white documents fairly quickly.

Printer developers still faced problems with the printer, namely because the flow of ink from the print head to the page needed to be controlled and because, at the time, dried ink would clog the printer head. IBM devised a strategy of using electrically charged droplets for coating the pages with ink but this failed due to a variety of reasons. It was here that Hewlett-Packard and Canon built on the idea of an inkjet printer by introducing liquid ink held in cartridges and just like that, a more efficient and consumer-friendly system was born.

If you are used to hitting your printer because it's not working like you want it to, think of the long journey it has travelled to be sitting on





thanked it too.

it makes the Electronics Industry what it is today. Be it the TV, mobile phone, laptop, supercomputer or telescope fitted on a satellite – ICs have changed the world our forefathers imagined for us. For the uninitiated, the latest processor chips from Intel house more than 2.2 billion transistors on a die which is merely 52.5x45 mm in area! Courtesy: Integrated Circuits.

Internal Combustion Engine

Around the world in 80 days might have been an unimaginable feat once. Fast forward to today: you could go around the world at least 20 times in that much time! Without a doubt, internal combustion engines are one of the best inventions of mankind. From auto-rickshaws to jumbo jets – they rule the roost of transportation systems.

While its roots can be traced back to the Romans, its true potential was realized only much later in the late 18th century during the construction of artillery weapons using non-fossil fuels like gunpowder. While history is full of events that made way for today's supercars, the title of a major breakthrough can be accredited to Karl Benz (of the Mercedes-Benz fame) for his patent of a two-stroke engine and later to British engineer Edward Butler and German engineer Rudolf Diesel for creating the petrol and diesel engines, in that order. It's those engines which developed, with time, into something that gives us wings, literally.

Internal combustion engines brought about major transformations. Carts pulled by horses slowly disappeared and in came an alternative which depended on fuel and was free of health hazards. Developments led to faster speeds, which in turn boosted industrial development and here we are today – booking tickets to fly to another part of the globe in 8 hours.



Were it not for internal combustion engines, our generation would have been snail-paced and ironically, healthier enough to be unafraid to walk for miles on our own feet. And of course, global warming would have been much less of an issue as well!

Internet

We all know that we can't live without our precious PCs, be they in the form a desktop or smartphone. But, of what use will those devices be without the internet? The internet is a phenomenon, and is truly the greatest invention of the last 50 years. It lets you reach out to a person a thousand miles away, in seconds. It gives anyone the ability to buy or sell things in moments, or gain access to the latest movies and music. It enables people to spread hatred at the speed of light, or become proficient in any field – science, art or sport.

From meeting old friends, to the meagre task of finding out the full form of an acronym, the internet has made us so entirely dependent on it, that life without it seems unimaginable.

The origins of the internet date back to the 1960s when the United States Government tried to build a secure communication route through computer networks. By mid 1980s, this led to being a worldwide project, and its commercialization in the 1990s resulted in its popularity and made it the

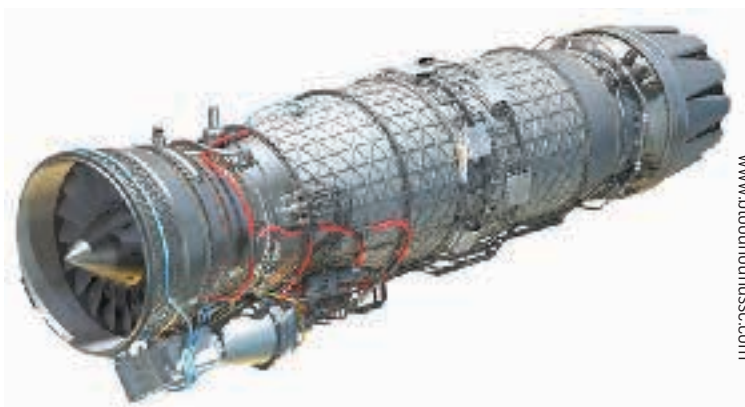
staple that it is in every computer user's diet. Internet has allowed for the cheap sharing of knowledge and skill, allowing people to work together on various fields across the globe; there are now global classrooms that enable equal learning across all countries and economic classes. With more than 2 billion users (more than a third of the world's population) online, the vast network of networks that form the internet has enabled it to brake all social and physical barriers and is solely responsible for making the world seem a very small place to live in.



Jet Engine

We often take for granted how easily a plane weighing over half a million pounds lifts off the ground with such ease. This miracle can be accredited to jet engines – an invention that uses Newton's third law of physics to create 'thrust'. Developed in the 1930s by Hans von Ohain in Germany and Frank Whittle in Britain, the modern jet engine represents the 80-year evolution of the gas turbine – a kind of rotating device that extracts energy from a fluid flow and converts it into energy.

Jet engines are a form of 'air-breathing' gas turbines in which the fluid (air) is compressed, mixed with fuel and burned at high temperature and pressure to create a flow of hot gas that spins the turbine. This jet of gas then streams out the back, creating a huge amount of thrust – equivalent almost to the power of 1,500 cars, enabling the plane to take off into air despite its heavy weight.



What's interesting to note is that in the case of jet engines, bigger is not always better. To measure the power of a jet engine, its thrust-to-weight ratio is more important than its size. Fighter jets and Turbo jets used for the fast warplanes and the supersonic Concorde therefore had higher thrust-to-weight ratios to enable high-speed manoeuvres and near-vertical climbs. However, though fast, these jet engines consume bucket-loads of fuel and are therefore not appropriate for commercial airplanes that need to maintain cruising speed while using fuel efficiently. It's thanks to the jet engine that today we're able to travel distances at speeds that would have been impossible 80 years ago. This invention truly changed the face of aviation forever.

Keyboard

The modern keyboard descends from two types of devices namely the teleprinter and keypunches. From the late 1940s until the widespread adoption of the mouse in the 80s the keyboard remained the primary, most integrated computer peripheral. Even today in the era of voice commands and touch screens, keyboards continue to remain central to human – computer interaction and tablets as well as smartphones are adapting the keyboard as an optional virtual means of data entry.

However, you may not know that the QWERTY layout used by keyboards even today was designed all the way back in 1972 by Christopher Sholes with the keys being purposely distributed randomly to reduce the



jamming of hammers used to create individual letters on typewriters. When computers hit the market, this layout was never changed to become more comfortable as all the secretaries were too used to the old format and did not want to change.

Nowadays keyboards come in all sorts of shapes and variants from one that can be strapped to your hand for doing work in tough conditions, foldable keyboards, laser keyboards that make any surface an input device or even one in the shape of individual hands for those that get pain in their hands from typing on traditional keyboards.

Laptop

Defined as a personal computer for mobile use, the laptop is a pioneering

device as it meant that employees were no longer chained to a desk to accomplish their work. Thanks to the humble laptop, people can now work while lounging on sofas in cafes and executives can put long hours spent at airport lounges to good use. The IBM 5100 was the first commercially



available portable computer, but laptops as we recognize them now didn't gain popularity until the 90s when colour display and high quality screen resolution became commonplace.

Since then, the term laptop has been used to refer to a number of small portable computers such as netbooks, ultrabooks and tablet PCs. Operable through both, batteries as well as AC adaptors, laptops actually use 90% less energy than desktops and today, outsell desktops. Beyond portability, in the age of smartphones and tablets what continues to make laptops a popular choice is their performance and comparatively low cost. And with laptops as light as 6 pounds, as thin as 1 inch and with screens as small as 10 inches being manufactured, they're the ideal device for the young and old alike.

Laser

Light Amplification by Stimulated Emission of Radiation, or Laser as we all know it's a device that emits light. Besides playing a pivotal role in Star Wars, Star Trek and countless other sci-fi movies, lasers show up



in an amazing range of products from CD players to dental drills to eye surgery equipment. They differ from other sources of light however as they emit light coherently, i.e. lightwaves that are not only all the same wavelength but also perfectly in step. Because of this quality, lasers can create an intense beam that can be focused to a tight spot, powerful enough to cause a hole in steel.

In fact, a laser beam is so straight and narrow that it can hit a mirror on the moon. While the first functioning laser did not come into operation until the 1960s, its theoretical foundations were created by none other than Albert Einstein years ago in 1917 in his paper on the “Quantum Theory of Radiation”. Today, there are all kinds of lasers such as gas lasers, chemical lasers, solid state lasers, fiber lasers, dye lasers and bio lasers for a whole host of applications. Weapon and medical technology aside, the most exciting innovation of lasers from a woman’s perspective is its ability to kill hair growth so that one never has to ever shave again. Also, the Bill & Melinda Gates Foundation funded *Intellectual Ventures* is developing a laser to kill mosquitoes to prevent malaria-related deaths.

LCD

A LCD or liquid crystal display is a flat panel video display that uses the light modulating properties of liquid crystals. From computer monitors to televisions and instrument panels to gaming devices, LCD’s are common



across a wide range of consumer devices and replaced the older CRT displays by 2007, when LCD televisions surpassed CRTs in worldwide sales for the first time.

Friedrich Reinitzer accidentally discovered Liquid Crystals back in 1888. However, they remained a scientific curiosity for about 80 years before George Heilmeyer built the first working LCD in 1964. It was manufacturer, Sharp Corporation that developed the first 14-inch colour LCD TV in 1988 and effectively brought it to the masses.

LCDs are used widely and available in a wider range of sizes than plasma displays today and since they do not use phosphors they do not suffer from image burn-in. Further, LCD monitors have been adopted by the United States military because they are small, lighter and more efficient. Also, LCDs offer razor sharp image displays, as there is no theoretical resolution limit and can be made to large sizes relatively inexpensively. Since its introduction, great advances have been made in LCD technology with Toshiba soon rumoured to be launching the first curved LCD TV shortly.

LED

Short for Light Emitting Diode and celebrating its 50th anniversary last year, LEDs have existed far longer than being the latest fad in display technology and for a far better reason than just providing superior contrast ratios for your cute little smartphone or desktop screens. It's possibly one of the most underrated scientific and electronics breakthrough that rapidly



propelled the digital age we all live in, and has made the incandescent and fluorescent light bulbs a thing of the past.

An LED (as we know it) is a type of diode (basic building block of any electronic circuit) that emits light (due to a phenomenon called electroluminescence) and was developed by Nick Holonyak, Jr., at General Electric in 1962 -- he's often referred to as the "Father of the Light Emitting Diode." Early applications of LEDs were found in seven segment displays (remember them from Casio watches or digital calculators?) and indicator lamps. These days, it's difficult to name an electronic device they aren't found in, they're that indispensable.

It all boils down to this. Not only are LEDs extremely power efficient, they are extremely durable and have a shelf life that's counted in decades. They don't have any mercury and are therefore, eco-friendly, they also don't produce much heat. Most importantly, they put on a show unlike anything else. All this while constantly undergoing refinements and transformations and upping the ante to a whole new level.

Lego

Placed in a town with a meagre 6000 residents, the airport in Billund still serves as Denmark's second busiest airport handling an average of more than two million passengers a year, and millions of pounds of cargo. It owes this remarkable popularity entirely to one of mankind's most ingenious inventions, LEGO bricks. LEGO is without a doubt, the most prominent toy company in the world. LEGO gets its name from the Danish words



LegGodt, meaning play well (coincidentally also meaning 'I put together', or 'I study' in Latin). Being all of only around 5cm³ in volume, an 8-stud LEGO brick forms the base for countless possible combinations (six same coloured 8 stud bricks can be combined in 102,981,500 ways).

Developing in the child a natural sense of imagination and critical judgement, LEGO has always been a hit with parents, teachers and children alike. Ranging from toy sets that involve building cars and ships to doll houses for girls, LEGO bricks are tailor-made to be enjoyed by all ages and genders alike. The LEGO phenomenon even extended on to the digital world having its impact on a variety of platforms – from LEGO based music videos to LEGO video games, LEGO enthusiasts have continuously captured fiction and events of the modern day, immortalising them in miniature. With more than 200 billion LEGO elements manufactured to date, it's of no surprise that LEGO was voted by Fortune magazine, as the "Toy of the Century", and also makes its way into the top 100 inventions of mankind.

Lenses

If objects around you begin to appear blurry and your eyes have to strain to focus, a trip to the optometrist is in order. What do you think the doctor would recommend? What else but another one of mankind's best inventions – lenses. A lens is an optical device that refracts light beams to make them either converge or diverge. Lenses are typically made of glass or plastic. Then there are lenses which don't refract light. Instead they refract the non-visual portion of electromagnetic spectrum, e.g. microwaves.

The Lens is one of those rare inventions which derives its name from an edible object – lentil. That's because a double-convex lens is lentil-shaped. The oldest known lens is a 3000-year-old rock crystal called 'Nimrud Lens' or 'Layard Lens' deriving its name from the ancient city of Nimrud, now part of Iraq.



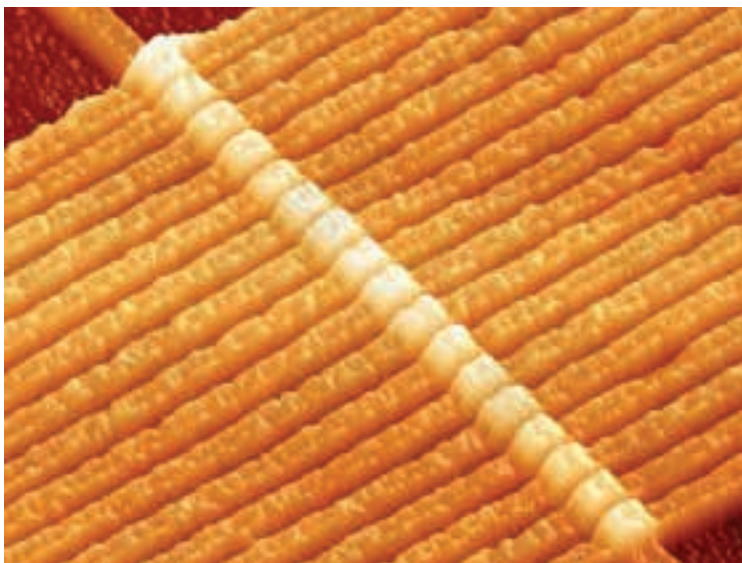
One of the most widespread uses of lenses is in aiding the correction of human eye vision. Binoculars would be second in the list while microscopes and telescopes would be the most advanced and fancy implementations. Lenses have gifted us with the ability to see as far as galaxies away and as near as the tiny cells in our bodies. We owe a lot of useful discoveries to their invention.

Memristor

Less than a decade ago, not many people were sure about the existence of memristors. Now, in mid-2013, memristors are re-defining fundamental electronics as we know them and bringing in a digital revolution of sorts. Believe us, that it's not an exaggeration.

Their story begins in 1971 when Leon Chua, an electrical engineer in his mid-30s, wrote a paper called "Memristor--the Missing Circuit Element" and predicted their discovery on mathematical grounds -- much like Mendelev predicted the missing elements of the periodic table. Chua argued that besides resistors, capacitors and inductors, memristors were the fourth basic (and until then missing) building block of an electric circuit. Forty years later, he's been proven right.

Memristors are passive components that "remember" the amount of current flowing through it. Thanks to research into memristive materials and technologies by companies like HP, Panasonic and memory manufacturers, we should be able to witness a ReRAM (Resistive RAM) module later this year. It's non-volatile, operates at lower voltages, denser than flash and quicker than DRAM. In fact, universal memory modules derived



from ReRAMs are on course to completely replace Flash, SSD, DRAM and SRAM drives in the next couple of years.

That's just the tip of the iceberg. We don't know how exactly, but memristors will usher in a new era of cognitive, neuromorphic computing that will propel advancement in artificial intelligence to a whole new level beyond the scope of our existing imagination. Companies like IBM, HP, and the world's leading universities, along with DARPA, are working on it. Not bad for an entity which was practically non-existent till about five years ago? Mind-boggling.

Microphone

A microphone or mic as it's more commonly known is a sensor that converts sound into an electrical signal. Over the years, they have come to become the core component in many other devices such as telephones, karaoke systems, hearing aids, radio, TV broadcasting and more recently VoIP.

Interestingly, the earliest known device to increase the volume of the spoken word was created in 600 BC with the invention of masks with specially designed mouth openings that acoustically augmented the voice in amphitheaters. In 1665 Robert Hooke was the first to experiment with a medium other than air with the invention of the "lover's telephone" made of stretched wire with a cup at each end. While the first mic as we would rec-

ognize it was created by Alexander Bell as part of his telephone, it's actually Thomas Edison who was awarded the patent for the carbon microphone almost 200 years after Hooke's' experimentation in 1877.

Microphones come in many shapes and sizes with dynamic mics being commonly used for live performances for their ability to soak in huge sound levels without the quality of sound being distorted. Condenser mics are used for studio recordings and radio transmitters. Nowadays, there is also the fibre optic microphone that uses optical fibers to absorb and produce sound – commonly used in the medical field where MRI suites do not allow staff to talk normally due to noisy magnetic fields – as well as Laser mics that are used in surveillance gadgets because of their ability to receive sound signals over a long distance.

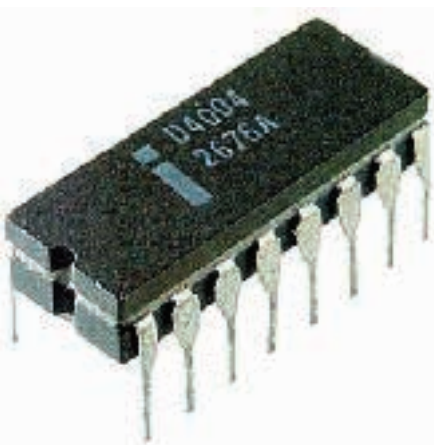
So the next time you go on a recording or karaoke marathon with your friends, think about all the fun you wouldn't be able to have if the microphone hadn't been invented – not to mention the fact that girls would be unable to call their crushes under the covers late at night thanks to the telephone where mics are a crucial component.



Microprocessor:

In 1971, Intel released the first single chip microprocessor, the Intel 4004, which cost 60\$. In an area of 3 by 4 millimetres, it consisted of over 2300 (Metal Oxide Semiconductor) transistors, and the tiny little miracle had as much power as the ENIAC, which had filled 3,000 cubic feet with 18,000 vacuum tubes. The credit goes to Intel engineers Federico Faggin, Ted Hoff, and Stanley Mazor. Intel's potential client from Japan, Busicom asked for 12 chips for different functions of a Busicom-calculator. Ted Hoff decided that they could build one chip to do the work of twelve- Intel 4004.

However Busicom never produced a product using 4004. In a clever move, Intel bought back the design and marketing rights from Busicom. With rapid development in semiconductor electronics, soon 8-bit, 16-bit, 32-bit and 64-bit microprocessors were developed. IBM selected the Intel 8088 for the first PC in 1981. In about a quarter of a century, modern computing reached sky high speeds.



However the speed of the microprocessor is limited by the main memory access time. Today we use multiple processors (or cores) to improve a computer's performance. Dual-core, quad-core processors are common among personal computers, while six, eight, ten, twelve and sixteen-core processors are more expensive and used in professional workstations. It's speculated that within 5 to 10 years, Intel will be able to fit 50 or so cores on a single chip with a 100 simultaneous threads.

Mobile Phone

One of the finest movies of Hindi cinema, Don has a car chase scene across the island city of Mumbai. Watching a movie made during those days makes you want to sit up and take notice of all that has changed over the decades- the cars, fashion and music sense, infrastructure, lack of people on the roads and most of all, the lack of mobile phones. You'll be hard-pressed to find yourself at a smartphone-free live concert of any sort these days.

Mobile phones (or 'mobiles' as we call them) literally brought about a sea of change. We no longer have to wait near a landline telephone for important calls. This round-the-clock companion has grown into a powerful assistant. Right from providing utilities such as alarm clocks and torch lights to entertainment options such as music and video and support for communication via voice calls, video calls, SMS, email and VoIP telephony, we've started using mobile phones for more than what they were invented for.

We've come a long way since 1946 when for the first time mobile phone



calls were made using two, 36kg bulky machines that used vacuum tubes. How was it like without a mobile phone? Well, here's what Martin Cooper, one of the very first users and creators of a mobile phone had to say:

“As I walked down the street while talking on the phone, sophisticated New Yorkers gaped at the sight of someone actually moving around while making a phone call. Remember that in 1973, there weren't cordless telephones or cellular phones. I made numerous calls, including one where I crossed the street while talking to a New York radio reporter – probably one of the more dangerous things I have ever done in my life.”

Modem

The modem is the key to accessing the internet, as we all know. Basically, modems modulate an analog carrier signal to encode and decode digital information. What you may not know though is that while cable and DSL modems are the most popular types of modem used for accessing information on the



internet, modems can actually also be used to transmit any kind of analog signals. Radio modems, for example, send data frames over microwave radio links while optical modems use optic fibers for sharing of data.

Modems came into existence around the 1960s when they were primarily used to communicate data between terminals and a host computer. In those times, they had a mind-bogglingly slow speed of 300 bits per second – to put it into perspective, an average movie download of 700MB would take over 20 days to complete! Now, compare that to the optical modems mentioned above which can transmit an incredible billion bits per second through the use of undersea optic fibers. While you may think that everyone would surely have shifted to these advanced optical modems by now, AOL in its 2012 annual report actually showed that it still collects around \$700 million in fees from dial-up users. In India too, the dial-up modem continues to remain popular in rural areas where cable and optical modems are yet to become a reality.

Mouse

We work with the mouse every day without even giving a thought to where it came from, when in reality it has come to define much of the way in which we use a computer.

Defined simply as a ‘pointing’ device, it was Douglas Engalbart who created the first mouse prototype in 1963. However, the actual ball-mouse that we’re all familiar with was only created later in 1972 by Bill English. Essentially created so that people could easily navigate through software without remembering keyboard shortcuts, the humble mouse too had its share of detractors with computer columnist, John Dvorak writing in 1984, “There is no evidence that people want to use these things.”

The mouse became a computer revolution in 1984 when Apple Macintosh hit the market and there was widespread adoption of the new computer. This is because the Macintosh was the first popular computer to use a graphics user interface instead of a command prompt interface and hence required a mouse to function. The benefits of the GUI became obvious after this and the mouse became a symbol of computing in the early 90s.



While today, the mouse generally has two buttons with a scroll option, there are all sorts of innovative spins on this popular device such as the mouse by Sony in Japan which doubles as a phone for Skype or mice that are in the shape of retro video-game characters or those that have also have a built-in clock. However, with the rate that touchscreen technology is taking over the world, it will be interesting to see how long the era of the mouse prevails.

MRI

Possibly one of the most powerful diagnostic tools, MRI scanners are used to image practically every part of the body, particularly tissues with many hydrogen nuclei and little density contrast such as the brain, muscle, connective tissue and most tumors. MRI technology works by using powerful magnets – strong enough to pick up a car – and radio waves to create a magnetic field, which aligns hydrogen atoms in the body. Radio waves are then sent from coils to specific parts of the body to cause hydrogen atoms to rotate



thereby producing electrical signals, which generate a map of the body.

While MRI machines continue to remain very costly at about \$1 million per machine they're incredibly useful with about 75 million patients globally getting an MRI each year. What's great about MRIs as compared to CT scans is that they're harmless to the patient and produce very detailed images. Interestingly, MRIs can also be used to detect areas in the brain that feel emotions such as fear, pain, love and happiness. These scanners have been used on monks serving under the Dalai Lama to study the control they exert over mental processes through meditation.

Moog Synthesizer

Arguably, no invention has affected the music industry as much as the music synthesizer invented by Robert Moog. Moog (rhymes with vogue), fascinated by earlier electronic music devices such as the theremin, went on to create the analog synthesizer in the mid 1960s. The analog synthesizer was far cheaper and smaller than any previous vacuum-tube based electronic instrument, thanks to the invention of the transistor (an amazing invention in itself). An ingenious combination of science and art, the moog synthesizer, contrary to the word synthetic, unleashed a range of rich and organic sounds, taking the music industry by storm. Moog went on to make a portable version called the Minimoog, which through its brilliant design allowed the user to change the shape of the sound in any way imaginable by simply adjusting the various knobs.

The synthesizer jumped into the spotlight after 'Switched on Bach',



an album by Wendy Carlos – made completely using synthesized music – won three Grammy Awards. Since then, an array of musicians such as *The Beatles*, *The Doors*, *Stevie Wonder*, *Mick Jagger*, *Kraftwerk* etc. have used the Moog synthesizer heavily to define a new sound heard in several generations of music across multiple genres. To get a basic idea of how the Moog synthesizer works, we suggest checking out the Google doodle made in tribute to Robert Moog on his 78th birthday. <http://www.google.com/doodles/robert-moogs-78th-birthday>

An electronic device and a musical instrument, many current professional musicians, even nearly 50 years after its invention, still consider the moog synthesizer to be the epitome of electronic instruments. Robert Moog and his invention have left an everlasting legacy on the music industry, thus making it one of mankind's greatest inventions.

Nanotechnology

In an after-dinner talk in 1959, Richard Feynman gave a talk about the building of molecular machines with atomic precision. Before him, James Clerk Maxwell in 1867, imagined an atom-sized device – known as Maxwell's Demon – that could trap molecules as they move in a specific direction. Whether what Feynman said was inspired or not by Maxwell is arguable, but they were both saying the same thing – doing big things with very very tiny things.



The idea of using nanotechnology in engineering was first applied by Eric Drexler. He said that if an atom was a marble then molecules could be seen as a collection of marbles. Interesting, but he went on to say something more relevant. He said that with nanotechnology we can be capable of constructing objects at any scale, atom by atom. This theory has been called naive by some, as he also claims that using this coal can be modified into diamond and laptop chips can be made from sand.

With nanotechnology, effective energy-producing, energy-absorbing and energy storage products in smaller and more efficient devices is possible.

So where is nanotechnology used now? In your food (diet supplements), medicine and also in the creation of stain-repellent khakis.

Nuclear Reactor

Enrico Fermi and Leo Szilard invented the first nuclear reactor in which nuclear chain reactions are initiated, controlled, and sustained at a steady observable rate. In Chicago, Fermi oversaw the design and assembly of what was called the 'atomic pile', the code name given to a 'nuclear reactor' so as to not cause panic during peace-time.

With World War II raging in Europe, the ability to produce an atomic bomb was considered of the greatest importance, and so Fermi was assisted in the development of his nuclear reactor.

Being the world's largest source of emission-free energy, generating



nuclear energy needed a device to initiate and control a sustained nuclear chain reaction and so we have the Nuclear Reactor. Four distinct 'Generations' of nuclear plants have existed through time.

Generation 1 reactors were the first to produce civilian nuclear power. Generation 2 designs were commercial reactors, but had the disadvantage of needing manpower to operate and not functioning if the power was shut off. This brings us to Generation 3 reactors which can function by themselves hence addressing, to an extent, safety concerns of working in a nuclear plant. And finally, Generation 4 reactors which right now are still in theory but will supposedly surpass all other nuclear reactors.

Obninsk Nuclear Power Station, situated 110 km from Moscow, was the first civilian nuclear power station in the world.

Operating Systems

"Real programmers program in binary" So goes a famous joke in the programming world, especially popular with the performance nazis. Truth be told, programmers programmed in binary once but this was when computers were just in their infancy. You'd punch your instructions on a card in the form of dots representing the binary instructions and feed them to the machine; the machine would then execute them. Any errors were only to be blamed on you. Since then, computing has come a long way, thanks to operating systems (OSes).

An OS forms a layer between the hardware and the application program while managing other programs and keeping an account of hardware resource usage. The program asks the OS for the resources (network, disk, display etc.) and doesn't have to deal with the hardware level details such as disk configurations, display resolution etc. In early days, OSes were written in the assembly language. These included OSes such as MULTICS and the first version of UNIX which were written in the assembly language of their target processor architectures. However, later Ken Thompson (also the creator of language 'B') and Dennis Ritchie created the C programming language to port UNIX to PDP-11 and since then, OSes have been written in C.

The invention of the OS started the true software revolution by reducing the amount of effort required to create a working piece of code. This encouraged more and more geeks to try out programming and discover new capabilities. To this day, almost any device that can handle number crunching runs some form of an OS.

Optical Media

Optical media is best exemplified by DVDs. If you're rereading this, you probably also got the disks that come bundled in the package, unless of course you're just borrowing a copy from a friend (in which case, you don't know what you're missing out on – we're talking free games, wallpapers and software here). Since you can use those DVDs to get your hands on cool stuff, you already know how important they are. But there is more than what meets the eye.



Developments around optical media began in the second half of the previous century but it was only in the late 70s that any progress was made. While Sony and Philips together invented the 'audio CD', Pioneer was the company that made the most out of the 'video disc'. The complete specifications for the first generation of CDs were made in the mid 1980s by Sony and Philips and the DVD came along almost a decade later.

Optical media is called 'optical' because it's read and written using laser beams. A successful reflection from the disk is read as '1' or '0' if otherwise. Optical media boosted the growth of the software industry. It made the distribution of content (primarily audio, video and software) easy from the point of manufacturers. Back in the day, a megabyte was seen as a monstrous amount of data which no one needed to store. However, as the industry grew and software packages increased both, in quantity and size, CDs became prevalent until the dawn of new millennia when DVDs started becoming mainstream and in 2006 came the Blu-Ray format. Optical media is not only good for content distribution but also serves well as a backup and storage solution. With the beginning of this decade, it has lost appeal in favour of cloud-based alternatives such as music and app stores and is all set to die in the coming future. Nonetheless it has served mankind well.

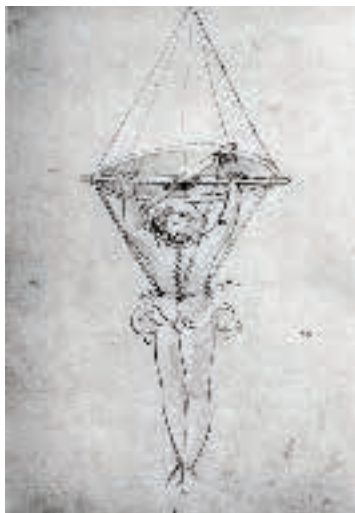
Parachute

The term derives its meaning from the French prefix *para* meaning 'defense

against' and the word chute meaning 'fall'. That's what a parachute does, right? The word was first used in 1785, the technology, much earlier. One of the earliest depictions of a parachute comes from the word, Codex Atlanticus of the most popular multi-talented person in history – Leonardo da Vinci. That was around the year 1485.

Since then, the list of scientists and countries working on the safety apparatus and tests done on it to arrive at the modern version is quite long. Desperate times call for desperate measures, a phrase that certainly rings true for the parachute, much of whose development happened during World War I and II.

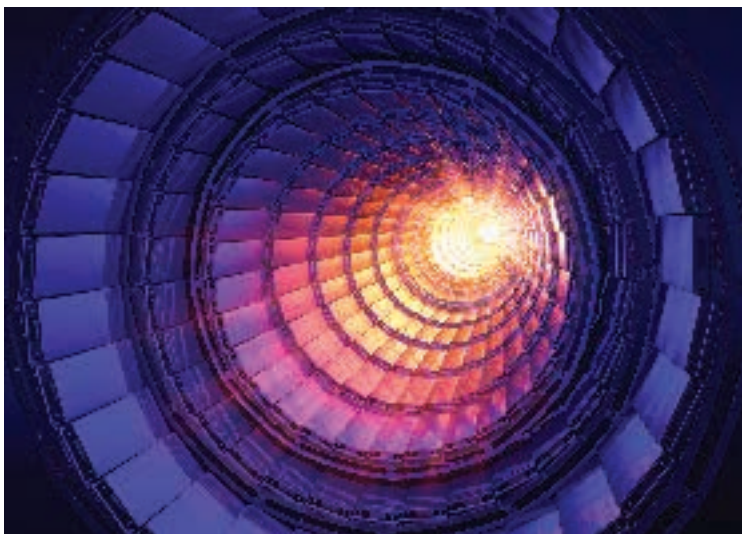
Speaking of wars, one of the biggest uses of parachutes has been to drop soldiers from the sky. That's not all. They're also deployed to drop basic amenities such as food and clothes in flood-stricken areas in times of need. Parachutes find application in fun and entertainment as well as in expeditions ranging from mountain jumps to shooting rovers to our planetary neighbour, Mars. While an energy drink company claims that its product gives you wings, it's the parachute that does it for real!



Particle Accelerators

Back in the day particle accelerators were called atom smashers. This misnomer relates to a class of accelerators known today as colliders (ala LHC), but the moniker certainly gives you a clue about what these machines are supposed to do. A particle accelerator uses energy to accelerate charged particles in defined paths. Sounds fancy, but you'd be surprised to know your old TV was a particle accelerator also. The cathode ray tube used in TVs of yesteryear is an electrostatic accelerator. The other type of accelerator is the oscillating field accelerator and it uses radio frequency electromagnetic fields rather than static electric fields to accelerate particles. The large hadron collider is an oscillating field accelerator.

It's estimated that there are 26,000 accelerators worldwide and only a



small fraction of them are used in fundamental particle research. Most are used for industrial purposes such as ion implantation (crucial to semiconductor fabrication) and radiation therapy (treating cancer). However, apart from these other uses the most exciting is still their role in unravelling the mysteries of matter. Particle accelerators are fundamental in experimental particle physics which quite literally gives us answers to the very existence and nature of matter, the origins of the big bang and the structure of the subatomic universe.

Penicillin

Ingesting fungi, in order to kill bacteria. That's the basic idea that Penicillin, the world's first antibiotic, works on. Sounds perverse, but the discovery of penicillin has increased the lifespan of humans from 20-30 years to what it is today.

In 1928, Sir Alexander Fleming observed that colonies of the bacterium *Staphylococcus aureus* could be destroyed by the mould *Penicillium notatum*, proving that it contained an antibacterial agent. This observation, later led to medicines that could attack and kill certain types of disease-causing bacteria inside the body. This is why the discovery of penicillin is believed by many to have been the start of chemical warfare on a microscopic scale.

Penicillin treats and prevents bacterial infections. Bacteria grows and strengthens within the body by continuously rebuilding their cell walls. Penicillin works by penetrating these cell walls thus damaging them and destroying the bacterial structure.



The main infections that are currently treated by penicillin are tonsillitis, STDs, urinary and skin infections, and those that cause weakening of the immune system. During World War II penicillin was the sole cause of the survival of thousands of soldiers, who would have otherwise died due to infection from their wounds.

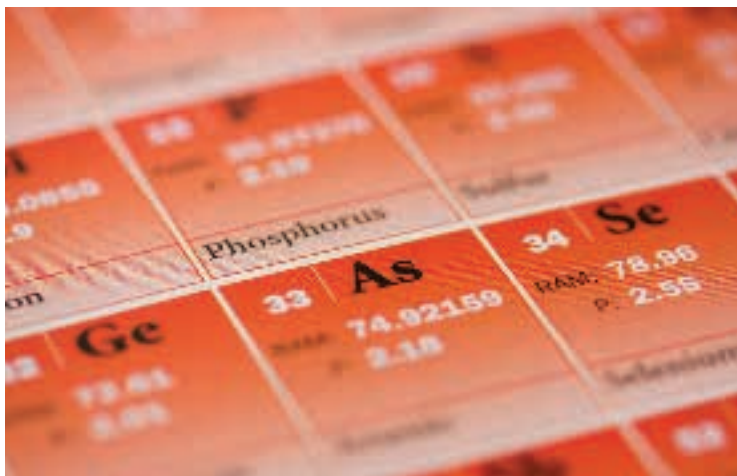
Penicillin wasn't successfully used until 12 years after its discovery. It's interesting to note that Alexander Fleming only rediscovered it; penicillin was originally discovered by a student named Ernest Duchesne.

Just goes to show how little attention is paid to students, doesn't it?!

Periodic Table

The first periodic table was noted by Alexandre-Emile Béguyer de Chancourtois in 1862, whom we shall call Al from now on, and not Dimitri Mendeleeev. All that hate in school was directed towards the wrong man.

Al arranged the elements in order of their atomic weight and wrote about this in a paper which was published in the French Academy of Sciences



journal *Comptes Rendus*. Unfortunately for AI, since he was a geologist and his paper mostly dealt with geological concepts, he wasn't taken too seriously. Mendeleeev, in 1869, had presented his periodic table, again based on atomic weights but this time it was accepted by the scientific community, probably because he was the first scientist whose name they could pronounce.

John Newlands had also tried his luck in 1865 but since his system put two elements in one box and didn't leave space for undiscovered elements it was criticized.

The present periodic table arranges the elements according to atomic number rather than weight because now we know what a proton is.

Why is the periodic table important? Other than decorating school walls, it helped greatly when all the natural elements were not discovered and it gives a rough idea as to whether an element is going to act like a metal or not and how reactive it will be.

Personal Computer

The addition of this invention on the list is a no-brainer. Considering the extent of our dependency on computers, it comes as no surprise that many of us would probably be tempted to pick the personal computer as the greatest invention of mankind. Absolutely every task that an average individual performs in his/her daily life has been simplified thanks to the revolution that has been the personal computer. From healthcare to entertainment,



banking to agriculture, science to industries – every sector in the world is run with the help of personal computers. The history of the invention of the personal computer is not very lucid though. The earliest electronic computers such as the ENIAC were not personal by any means; they were enormous and extremely expensive. But after the invention of the microprocessor, computers became smaller, and thus the “microcomputer”, soon known as the “personal computer” was made. In the 1960s and 70s, many computers were developed with each offering something more than its predecessor, and the debate still rages on as to what the first ever personal computer was, with the credit usually given to the IBM SCAMP, the Xerox Alto or the HP 9830. However, two engineers from Silicon Valley, named Steve Wozniak and Steve Jobs built the most well known PC release of the 70s – the Apple I – and changed the world as we know it. The PC revolution had begun, and soon major companies entered the market, thus making personal computers a mainstay in every home and office. The advancements in technology allowed personal computers to grow in performance and make them more user-friendly. Today, along with desktops, laptops, smartphones and tablets ensure that we have a PC with us wherever we go.

Photovoltaic Cell

Mankind's probably been obsessed with the Sun – our nearest star – since the dawn of our species. But we didn't quite appreciate its utility as a source of energy until our overdependence on fossil fuels and the prospect of them run-

ning dry all of a sudden started staring us in the face. We couldn't just hide behind layers of sunscreen anymore. Something more needed to be done.

Albert Einstein first explained the principle of photoelectric effect in 1905 – having to do with converting light



into electric current – getting a Nobel prize for his troubles. But it wasn't until 1954 that the blueprint of an efficient, modern-day photovoltaic cell was conceived in Bell Laboratories. At the heart of a photovoltaic or solar cell is silicon – the same substance used in computer chips – which is tasked with breaking down photons into electrons. It's not the most efficient way to be honest and it ain't cheap. Still, every country in the world is making a beeline towards solar power plants based on photovoltaic solar panels. Germany has the largest installation in the world generating 32.3 gigawatts, while China produces about one-fourth of all photovoltaic products in the world. India's very own Charanka Solar Park in Gujarat is currently the second largest solar power plant in the world.

But the photovoltaic cell is far from perfect. Scientists and researchers are constantly trying to find ways to boost its efficiency. Just last month, a team from MIT suggested that if silicon-based photovoltaic cells are coated with an organic dye called pentacene, it can dramatically increase power output to over 30 percent. More electricity from the same amount of sunlight. That has to be good news since these cells play such a crucial role in clean, renewable fuel in our quest for a greener future.

Plastic

While organizations fighting for environment preservation might not agree, plastic is one of the most important inventions ever. Wikipedia defines it as “any of a wide range of synthetic or semi-synthetic organic solids that are mouldable. Plastics are typically organic polymers of high molecular mass, but they often contain other substances.” The origin of artificial plastics is not completely clear but polystyrene, polyvinyl chloride (PVC) and rubber



laid the foundation for its existence. Parkesine and Bakelite are some of the early developments in the field while a number of synthetically altered natural substances (chewing gum, for example) were coming into use.

Plastic's biggest advantage is its non-biodegradability which made it a strong contender for use as wrappers and containers. Various materials in the group with more strength and durability found their use in other areas such as electric and heat insulation. Plastic is extremely resistant to corrosion and can be easily molded into any desirable shape and hence qualifies for a cheap alternative to many household objects such as plates, pipes, furniture etc.

Given its reusability and cheaper cost of production, it's easy to see why there's so much of it around us. Since the material is comparatively harder to decompose, the method of recycling it is the key to a cleaner, greener planet. The improper ways by which plastic is disposed has vilified it as an anti-nature product.

Propeller

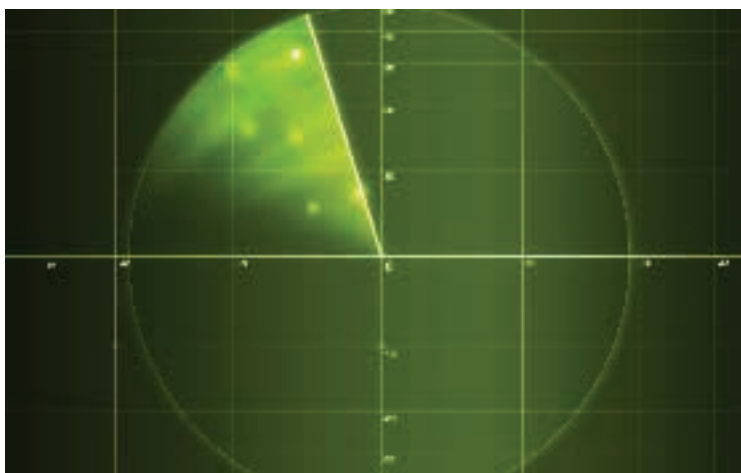
A type of fan that transmits power by converting rotational motion into thrust, a propeller is used by both, ships as well as planes. Propellers work by creating a pressure difference between the forward and rear surfaces of the airfoil-shaped blade and a fluid such as air or water is accelerated behind the blade. Invented by Josef Ressel in 1827, his ship 'Civetta' was the first ship to be successfully driven by a propeller.

Amongst aircrafts, the Wright brothers pioneered the twisted airfoil

shape of modern propellers in the 1903 when they performed their famous first powered flights. These were different than marine propellers as they included a twist along the length of the blades to ensure the angle of attack of the wind on the blades was kept relatively constant along their length. By the 1920s, the understanding of propellers was in fact complete and today, 100 years later modern propellers are only about 5% more efficient than they were almost a century ago.



For the geeks amongst us, you may be interested to note that any given propeller's size is described by two numbers with the first representing the diameter – critical when converting engine horsepower to thrust and the second representing the pitch, that is the distance the propeller moves with each complete revolution. Airplanes driven by propellers are ideal for applications where efficiency and cost outweigh speed requirements, which is the primary reason why airlines today continue to use these types of planes for short regional flights.



Radar

The concept of using sound waves to gauge the distance of objects around you was a well kept secret in the bat-circle till Lazarro Spallanzan, in 1793, figured it out when he studied the ability of blind bats to navigate using ultra-sound and from there the initial concept of SONAR was born, which eventually gave way to RADAR, without any credit given to the bats.

With the Titanic disaster, the need for finding an effective anti-collision system spurred research on RADAR as a system. Robert Watson, a Scottish physicist, felt that its applications could also be found in war and so designed the first practical RADAR system. This was used by Great Britain in World War II for aerial surveillance and is touted to be one of the reasons for their success. Funnily enough, the Germans had also built their own air defence system at the same time called the Kammhuber Line.

Radar finds use in navigation of ships and planes, by the police for catching speeding automobiles and controlling traffic, prediction of the weather, tracking of migratory patterns of birds, and of course by the military which uses it for tracking or gunning down unwanted elements.

Radio Transmission

While some say that it was Nikola Tesla who invented the radio, others say it was Guglielmo Marconi. But the best version of these stories is that our own Jagadish Chandra Bose was the one who invented it. JCB demonstrated radio transmission in 1896 in Calcutta in front of the British Governor General and had solved the problem of waves not travelling through walls or water through his 'Mercury Coherer with a telephone detector' device. Marconi's Coherer, which he used in 1901, was an exact replica of it. The story goes that Marconi stole JCB's notebook in which the Mercury Coherer was drawn, and so when asked how he came up with the design, he fumbled like



a snotty little boy and lied that he got it from someone else, but this lie was also found out. We'd like to believe that JCB met Marconi outside wherever scientists meet and made him regret that he did anything like that, but we can safely assume that JCB was a bigger man than that. He even declined to file a patent for his device, believing in information to be free to allow more research, and only filed a patent by 1904 on the insistence of his friends. By then, slimy Marconi had already received his patent and international recognition, leading us to conclude that he was either very very smart or that history is just trying to make us lose hope in humanity.

RFID

Originally used to track large items, such as cows, railroad cars and airline luggage, that were shipped over long distances, the RFID system might take over the barcode system since it is finally become cost-effective enough for application. Charlie Walton invented the first version of the RFID in 1973 and received the patent for it in 1983.

So what can the RFID do? Well, imagine walking into a supermarket, picking up the items you want and walking out. No no, don't go out and do it right now. See once RFIDs are fully implemented, when you pick up an item and keep it in your shopping bag the RFID will read and understand whichever products you've picked up and will follow a chain of commands



till it reaches your bank which will remove the respective amount from your account.

Right now, RFIDs are being used in tracking vehicles, Alzheimer patients, and even pets. With the move to introduce the RFID more extensively into people's lives comes some criticisms. Some say that there are privacy concerns as anyone else can read your RFID and steal data. Most hilariously, there is also a section of people who believe that this is an omen foretold by the Bible about the coming of a beast, i.e. the devil, since we'll be marked (RFID attached) by the devil. So the world is probably going to end sometime soon. Again.

Robots

Robots, or at least the idea of robotics has captivated mankind ever since levers, pulleys and other simple machines were being combined to make life easier for everyone. Robots or more accurately automations have dominated mythology and fiction even before working models were ever built. Historical accounts of automatons go back to 10 century BC China in the written accounts of Lie Yukou. However mythologies often speak of mechanical human-like servants such as those built by Greek



god Hephaestus or the infamous Golem of Jewish origin. In fact you'll be surprised to know the word robot itself means "serf labor" in Czech. The more colloquial usage of the word relates to "drudgery" or "hard work". One of the first recorded designs of a robot (as we think of it today) was sketched by none other than Leonardo Da Vinci in 1493. The sketches depict a mechanical knight capable of moving arms and sitting up.

Much later the industrial revolution gave rise to assembly line robots that were to work for performing repetitive tasks. Today you have semi-autonomous robots such as Honda's Asimo (pictured alongside). The pace at which robotics and artificial intelligence is progressing singularity may not be that far ahead. When that happens let's hope that the robots will take Asimov's three laws of robotics seriously and not massacre us.

SatNav/GPS

Global Positioning System (GPS) is a satellite navigation system. It provides



real-time location and time based information based on data from GPS satellites positioned at various points around the Earth.

Developed in 1973, by the US Government all you need to access GPS is a GPS Receiver. Credit for its invention goes to Roger L. Easton.

GPS is based on the principle of Triangulation which is basically the process of determining the location of a point by measuring the angles made to it by three known points. GPS triangulates off satellites to pinpoint your exact location. 3 satellites are required to provide latitude and longitude data, and a fourth for altitude. There are 24 GPS satellites currently each with its own atomic clock on board. Moving at the speed of light the satellites synchronize data so that their signals are transmitted at the same instant.

The satellites are maintained by the United States Air Force, and orbit with a period of 12 hours. The GPS receiver is aware of the position of the satellites by the transmissions they give out.

The accuracy of GPS is estimated to be within a 10-20 metre range for handheld devices. Other devices use a method called Differential GPS and have a much higher accuracy rate.

Not only does GPS store your current location, but your past locations as well. So in addition to knowing where you are now, you can also know where you've been this morning, or all week for that matter. This is why, I suppose, it is commonly referred to as the ultimate stalking tool.

Satellite TV

The two-month cricket extravaganza that is the IPL couldn't have been a success, if not for the nifty satellite television. Delivered through communications satellite and received by an outdoor antenna (read: satellite dish or set-top box), satellite TV enables us idiot box addicts to access a wide range of channels that are often not serviced by cable providers.



This is because even though conceptually satellite television is a lot like broadcast television, what makes it unique is its range and clear signal. Since satellites orbit the planet, there are many more customers in the line of signal. They're all also in geosynchronous orbit, meaning that the satellite stays in one place in the sky relative to the earth so that the signal doesn't need adjusting once the satellite has been launched.

While it may continue to remain one of the least understood technologies for television reception globally it hasn't stopped droves from signing up as new satellite customers primarily because the broadcast is completely digital which means much better picture and sound quality. The best thing about satellite TV in India is that we now have so many channels that one can spend a good two hours just browsing through them all searching for the best show to watch.

Scanning Tunneling Microscope

Gerd Binnig and Heinrich Rohrer developed the scanning tunneling microscope in 1981, presumably because they found viewing through standard microscopes 'uncool'. An older version of the STM was the 'topografiner' invented by Russel Young and his colleagues between 1965 and 1971.

A super fine tip is taken and kept at a distance of one nanometre away from the sample. The tip is charged and hence electrons start flowing from the tip to the surface in a process called 'tunneling'. The current flowing through the tip is kept constant by scanning the tip over the surface horizontally and by adjusting the height of the tip vertically. This results in a 3-D image of the surface, which in our opinion is pretty damn cool. Because of the 3-D structure, one could make characterize surface roughness, observe surface defects, and determine the size and conformation of molecules and aggregates on the surface.



STMs are also advantageous because they can be used in ultra-high vacuum, air, water, other gases, as well as from temperatures as low as -273 degree Celsius to around 300 degree Celsius. Their only drawback is that they require quite a bit of skill to use and are very fragile so forget running and buying one for yourself. Also, it costs only about \$8000 for the cheapest STM.

Sophisticated Fibres

It's mind-boggling to think where mankind would've been without radical materials. From simple shoelaces to lighter trainers to stronger aircraft, advances in material sciences have literally transformed ordinary things forever. Some of these advances include Fibres. Take the case of Velcro; something that we take for granted today. The fibre has a 1955 patent



(in the name of one George de Mestral) and was inspired by the way burrs (a prickly fruit) stick to the fur of animals. In the '60s Japanese researchers experimented with ways in which polymers can be infused with carbon fibre inventing strong and light composites, with never before seen strength-to-weight ratios. Everything from fishing rods to F1 cars and aerospace engineering benefitted from this. In 1965 DuPont created a high strength para-aramid synthetic fiber called Kevlar. (Counter Strike players are probably nodding their heads right now). Kevlar is literally bulletproof. Even the now ubiquitous "Fibre Optic" is a fibre. (Be sure to check out that entry)

Sound Recording

Thomas Edison invented his tin-foil phonograph which played recorded sounds from round cylinders. While working on improving the telegraph transmitter, he noted that weird sounds which sounded almost human were given off by the tape of the machine when played at a high speed. Edison, who was probably scared out of his senses before he realised that he was a scientist and then with a new-found bravado, reasoned that he could probably record a human voice. He experimented with the diaphragm of the telephone receiver by attaching a needle to it and came to the obvious deduction that the needle could prick paper tape to record a message. To everyone's surprise, this worked and was the first Phonograph or recording device. It was first marketed as a dictation device and was only later modified for recording music.

In 1887, Emile Berliner put forward a successful system of sound recording. Berliner was the first inventor to stop recording on cylinders and start recording on flat disks or records.

Now if you were to look up Thomas Edison you will be greeted by lots of people ranting about how he is a thief and how he stole ideas and patented it for himself, and so was more of a shrewd businessman other than a scientist. We recommend you to take these opinions with a pinch of salt since anyone can write on the internet, and soon you might find out that you in fact had invented the phonograph.



Switches

You'd think a piece of plastic generally found on walls would not figure in the top 100 inventions. But switches go beyond a fan or light button, they are implemented at micro levels on electronic systems to control multiple parallel circuits. The keyboard would be an array of switches that



inputs a certain letter when the button is pressed. Switches are extensively used in electrical systems and huge machinery where control systems need to be in place for its functioning. Magnetic, push button, slide, rotary, toggle switches are a few types. In electronic systems the circuits use relays and transistors to implement switching. Several techniques of commu-

nication in electronics like time, frequency, phase multiplexing require switching. Switches offer control mechanisms and their use in any kind of an electronic system cannot be understated.

Telescope

The mystery of what lies beyond our vision will forever haunt us. But the telescope is the invention that has helped put all of it in perspective – our place and purpose as a species in the universe, the size of our world, and the space around it. Considered one of the central instruments of the Scientific Revolution of the 17th century, the telescope has brought within our grasp, the solar system and everything beyond the barriers of the earth, proving that the earth is nothing but a big circular rock. It has radically changed who we, as a species, think we are. It has helped give birth to the modern science of astronomy, and hence helped prove/disprove various theories related to earth and the stars.

Credited for the invention of the telescope is Dutch eyeglass maker, Hans Lippershey, who applied for its patent first. However, Galileo Galilei was the first to use it to observe the heavens, and made great improvements in its technology, later finding craters on the moon, and discovering the four largest moons of Jupiter. The first practical telescope though, is credited to Newton since previous telescope designs were rather large and not so easy to use. Over the years, the ability of telescopes to gaze deeper into space has grown exponentially. The famous Hubble telescope (named after Edwin Hubble) orbits the earth once every 96 minutes, and has led to discoveries such as the age of the universe, or the fact that the expansion of the universe is speeding up, contrary to popular belief. The telescope keeps unravelling the mys-



teries of the universe and reminds us as to how miniscule we are in this staggeringly huge cosmos, and thus is definitely one of the greatest inventions of mankind.

Television

IPL fever hits India, again. Imagine this: your favourite team is on the ground in the finals– one wicket remaining, 3 runs to win, 1 ball to go. God forbid, but what'd be your emotion if the TV stopped working at that moment? Well, for the love of the game, there would be pure anger. Television has become such an integral part of our lives that we often forget that it's just a screen, not a series of actions actually unfolding in front of us but miles away, sometimes thousands of miles away. It's hard to imagine life without our idiot boxes, which were conceived more than 100 years ago.

A little-difficult-to-digest fact is that one of the first televisions made in 1907 was not completely electronic– it was electromechanical. In 1911, one of the very first television transmissions was done using mirror drums and CRT technology that used selenium cells. Due to the lagging nature of the cells, moving pictures were not possible back then. By 1927, CRT technology matured and by 1950s, television were being put to practical use. With the help of camera and recording technologies, shows started airing.



thinkdit www.thinkdit.com

Television changed a lot of things. Advertisements were no longer served only on paper. A whole new generation spruced up which didn't know how it felt not being able to see something 'live'. Fast forward to today and we have multiple channels and an abundance of content to consume. The entertainment industry as we know it is a child of the television.

Touchscreens

While the coming generation might not drool over the marvels of touch technology, users of CRT monitors and black and white LCD screens on mobiles will most definitely appreciate it. Touchscreens enable you to interact with a computer display by a mere touch of your finger or stylus, replacing the need for a mouse click or button press. In smartphones and tablets, the mouse pointer is also hidden.

Would you be surprised if we told you that Apple wasn't the pioneer of the technology but only an innovator; and that the research had begun almost 50 years ago? The first paper that was published on a touch-capable screen dates back to 1965. But the technology was immature. Between 1979 and 1985, they were used in a then high-end musical sampling and synthesis workstation. The device worked with a 'light pen', comparable with a stylus today. Development by Apple began in 1987 on a touch device which was named Newton, and it was released in 1993. It was one of the first PDAs which could use touch input. Today we have resistive and capacitive touchscreens, with the latter being clearly more advanced.

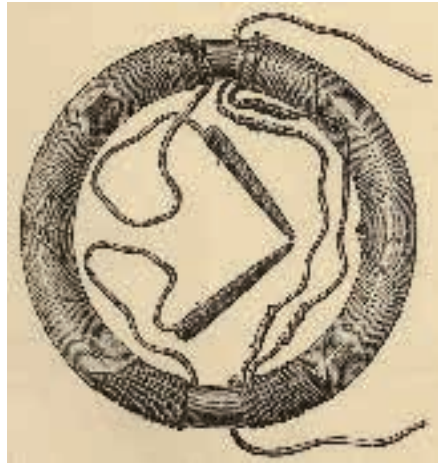
Touchscreens enabled developers to design better apps for mobiles



and freed them from the restriction of the two option buttons and 12 keys for input. Using touchscreens, one can use the entire display screen real estate which would otherwise be eaten into by a keyboard. This head-turning technology has great market value, and the result – a huge adoption rate for touch devices. All types of applications are being ported onto mobiles and being made ready for touch input these days. Touchscreens have changed the way we use computers and will continue to do so in the future as well.

Transformers

Alternating current would have been impractical and dangerous were it not for those boxes on the side of the streets which step down enormous voltage (about 11,000 volts) to a usable level (about 220 volts) to light up our houses, without burning them down. Transformers were invented by the famous physicist Michael Faraday and work on the law of induction established by Faraday himself.



Faraday's law of induction states that a potential difference is caused in a conductor when it is exposed to a varying magnetic field. Based on this principal, the transformer houses at least two coils – the first causes the varying magnetic flux and the other uses the same flux to convert it back into electricity. The differences in voltage are attributed to factors such as material used in wires, number of rounds, thickness of wires and so on.

Transformers can cause electrical isolation of two circuits preventing direct current from passing from one circuit to another, lower or raise voltages (You probably have an automatic voltage stabilizer for your refrigerator which uses a transformer to function) and help lower power wastage during transmission. It is the last property of transformers that makes them suitable for distributing electrical power.

Transistor

Invented in 1947 at Bell Labs by John Bardeen, Walter Brattain and William Shockley, the transistor is a semiconductor device used to amplify and switch electronic signals and electrical powers. This little invention revolutionized the field of electronics and paved the way for cool things that we'd probably be unable to live without in 2013 such as the calculator, computer and radio. Why? Basically, a transistor is like a miniature on-off switch that allows a computer to process information. Computers can't operate without an integrated circuit (chip) and a chip can't operate without a transistor.

In the 1950s, the first transistor radio used only four transistors while in 1971, the first Intel chip used 2300. The latest chip has 820 million of these little miracles. Even more interesting is the fact that the original transistor could be held in your hand while current transistors are so small that more than two million 22nm tri-gate transistors could fit on the fullstop at the end of this sentence. Today, more than a billion Nobel prize winning transistors are manufactured across the globe every second.

Turbines

The turbine is almost single-handedly responsible for the technological advancement of the human race. Everything from the humble Windmill to the super-efficient turbo-jets in advanced fighter aircraft to even the super-massive cores of power stations is based on a turbine in some way or the other. The very nature of our existence is based on the amount of power we harness and the turbine is the only device that can harness it at the rate we require.

The origins of this design are long lost (who actually did create the first windmill or water wheel?) but it was only with the invention of the

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steam turbine, more specifically, the reaction and impulse turbine designs by Sir Charles Parsons and Gustaf de Laval in the early 1850s did the turbine truly come of age; giving man the ability to efficiently harness the power of steam.

USB

The Universal Serial Bus or USB as we better know it is an industry standard that has effectively standardized the connection of computer peripherals such as keyboards, cameras, adapters and chargers to personal computers to communicate, transfer data and supply electric power. Over 6 billion USB 2.0 ports have been sold till date and a 3.0 super speed version has now become the industry norm to support transfer of data from high-end media devices that require faster transfer speeds.



Its sister, the USB flash drive has also experienced similar popularity. Introduced as a durable and faster alternative to floppy disks has completely replaced the aging floppy disk market. Furthermore, gone are the days also when USBs used to cost a month's allowance and were only available in boring black. These days they come in every conceivable shape size and colour for a fraction of the cost.

Interestingly though, despite having the word 'Drive' in its name, a USB drive actually has no moving parts – it's only because it uses the same system commands to read and write data as a traditional mechanical disc drive that this name was given to the humble USB. While the way the USB works continues to be a mystery for many, what makes it a great invention is its durability. The average USB drive can survive falls, pressures and temperatures that other devices would fail under. For example, highly robust flash drives can survive being run over by 10 tons of pressure and survive temperatures of -122 degrees Celsius – mind you, don't try that with the \$10 one you bought at the thrift store.

Vaccination

The vaccine has been the saviour of our civilization against fleet after fleet of epidemics that we have had to face across the ages. One of the most



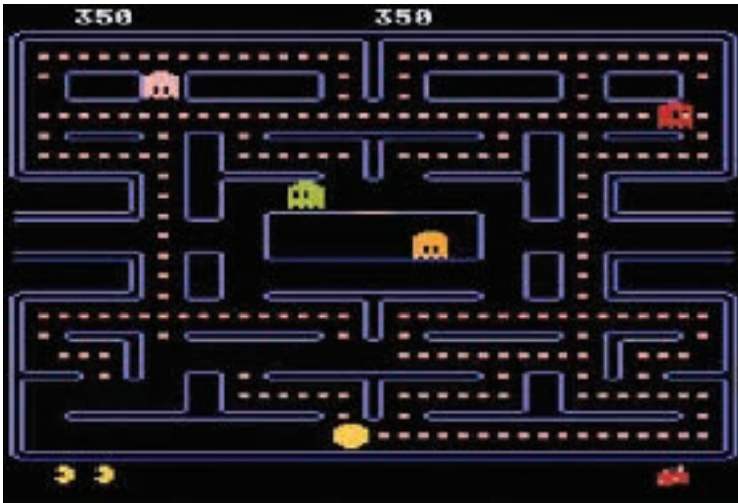
important inventions ever, the vaccine has literally saved millions of lives, and continues to enable people across the world to lead normal, healthy lives. Infact, we might not have existed as a race if not for vaccines.

The invention of the vaccine dates back to the long history of infectious diseases in humans. There is evidence that the Chinese and the Indians advocated smallpox inoculation as early as the 16th century. However, the first vaccine is credited to Edward Jenner, who made a smallpox vaccine in 1796. He realised that milkmaids, who worked with cows, did not develop the disease, whereas all the others did. After further research he concluded that the cowpox virus (contracted from cows) gave its victims immunity to smallpox. He then administered the cowpox virus to a boy, and once the cowpox symptoms died off, he injected in him the smallpox virus. The boy, however never became ill with smallpox, and this experiment is known as the world's first vaccine. Word of this spread like fire, and in only 5 years, more than 100,000 people had been vaccinated. In 1885, Louis Pasteur made a breakthrough in vaccination, by making a vaccine against rabies, the first vaccine not made for smallpox. Slowly, vaccines for various diseases were made, and vaccination had become so widespread that by 1980, smallpox as a disease had become eradicated. Diseases such as polio, measles, mumps, hepatitis, chickenpox, pneumonia have all declined by great amounts thanks to the introduction of vaccines against them, with some such as polio even close to eradication. Now, mil-

lions of vaccines are administered every year, and millions lead a normal life thanks to this beautiful invention.

Video Games

The video game heralded the start of a new generation of entertainment for both, children as well as adults. Played on platforms ranging from large mainframe computers and arcade stations to handheld devices, video games have changed since their introduction in the 1970s as simple shooter or brick games to become an art form and an industry. It was Taito's



shooter game Space Invaders that marked the beginning of the golden age of arcade video games and inspired dozens of manufacturers to enter the market with Super Mario, Donkey Kong, Aladdin and Pac-Man being the most popular games of the 90s. Nintendo's original Game Boy was in fact the most successful game system ever, with more than 100 million units sold worldwide.

As computers and their performance capacities improved, the quality of video games also made headway. Sony Playstation, Xbox 360 and Nintendo Game Cube made sure that video games were adopted by 72% of American households and almost \$25.1 billion was spent globally on video games, hardware and accessories in 2013. With game technology improving almost continuously, 3D gaming and motion sensor gaming

has quickly become a reality and is predicted to disrupt the mature gaming industry once again.

VLSI

As the size of transistors kept on reducing researchers began to toy with the idea of having more number of transistors on a single chip to create powerful integrated circuits. This process is exactly what VLSI or Very-Large-Scale-Integration is all about. Today millions (nay billions) of transistors can be combined into a single chip. The cost and performance benefits of integrated circuits is what makes computing so ubiquitous and easily accessible. The first rudimentary idea for integrated circuits can be traced back to German engineer Werner Jacobi in 1949 when he filed a patent for a device that showed five transistors on a single substrate. However the idea really took off when Jack Kilby of Texas Instruments filed his own patent about 10 years later. (Check out the entry on integrated circuits for more info). The first breakthroughs in VLSI can be traced back to the '80s though when the number of transistors reached the thousands. Moore's Law anyone?



Voice Data Transmissions

Though we now know the telephone as the mobile phone, its basic purpose remains the same – communication. The Telephone is undoubtedly one of the greatest uses of electricity. Though there have been claims stating otherwise, the invention is largely credited to Alexander Graham Bell. This was the first device that enabled human beings to speak to each other over very large distances. Using the vibrations produced by human speech and converting it to analog, electrical signals changed the world forever.

Though telegrams were already being used for long distance communication when the telephone first came into being, it stood out to due to its practicability, allowing communication to happen in real time which wasn't the case with telegrams. The technology took its own time reaching the hands of the common man and the prices of phones dropped after large networks started operating to run business around the communication industry. The concept of transferring voice data over wires led to another obvious idea waiting in the wings – wireless telephony. It was also discovered that signals that can carry data other than voice can also be transmitted over wire, and this pioneered the internet age. Anyone who's used the old 56Kbps modem making Dubstep music before it was cool would appreciate how far we've come. Just as the steam engine started the transport era, the telephone kicked off the communication era. Mobile phones, internet, Wi-Fi and undersea cables were all inspired by voice data transmissions.

Wi-Fi

Who doesn't know what Wi-Fi is? It's the magic by which bits and bytes of data travel wirelessly all around us into our gadgets. Imagine Tablets, Laptops, and Smartphones without the magic of Wi-Fi... a bleak thought indeed. But ever wonder how Wi-Fi works? Or how it got its name? Technically it was supposed to be called "IEEE 802.11b Direct Sequence". Not the best name is it now? Well the Wi-Fi Alliance didn't think it was too catchy either and hence hired a brand consulting firm called Interbrand to create a brand identity for Wi-Fi. The origin



of Wi-Fi isn't that exciting though. It had more to do with the US government opening up the ISM band for unlicensed use through a 1985 ruling. But the workgroup had been working on wireless transmission for quite some time. Incidentally, the head of the workgroup Victor "Vic" Hayes is hailed as the father of Wi-Fi for his contribution.

World Wide Web

The Web is the best thing that happened to the Internet. While the two terms, internet and web might seem synonymous, there's a difference. The internet is a collection of interconnected computers while the web is the collection of interconnected web pages, or as Wikipedia says: "The World Wide Web is a system of interlinked hypertext documents accessed via the Internet." Technically, WWW is a service which works on the internet (email is another example). So, though a chat, email or database server might be a part of internet, they're not directly a part of web (even if they happen to be used to show web pages).

The earliest version of the web was the work of a single man, namely Tim Berners-Lee, a British computer scientist who started playing around with hypertext in 1980 as part of a personal database of people and software models. In 1989, he wrote the first proposal for the standard and in 1990, the second one was written by Tim's colleague Robert Cailliau while he was working on the developments of [HTTP](#), HTML, web browser and web server. During 1992 to 1995, the technology took a huge leap forward. It was during this time that W3C (World Wide Web Consortium) was founded and took charge of standardizing the web. Had it not been for the web, you'd have a more social life than your Facebook statuses imply but you'd also not have such a vast sea of information at your fingertips!





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